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SEPTEMBER 1993

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THE HYPERSONIC SKYHOOK

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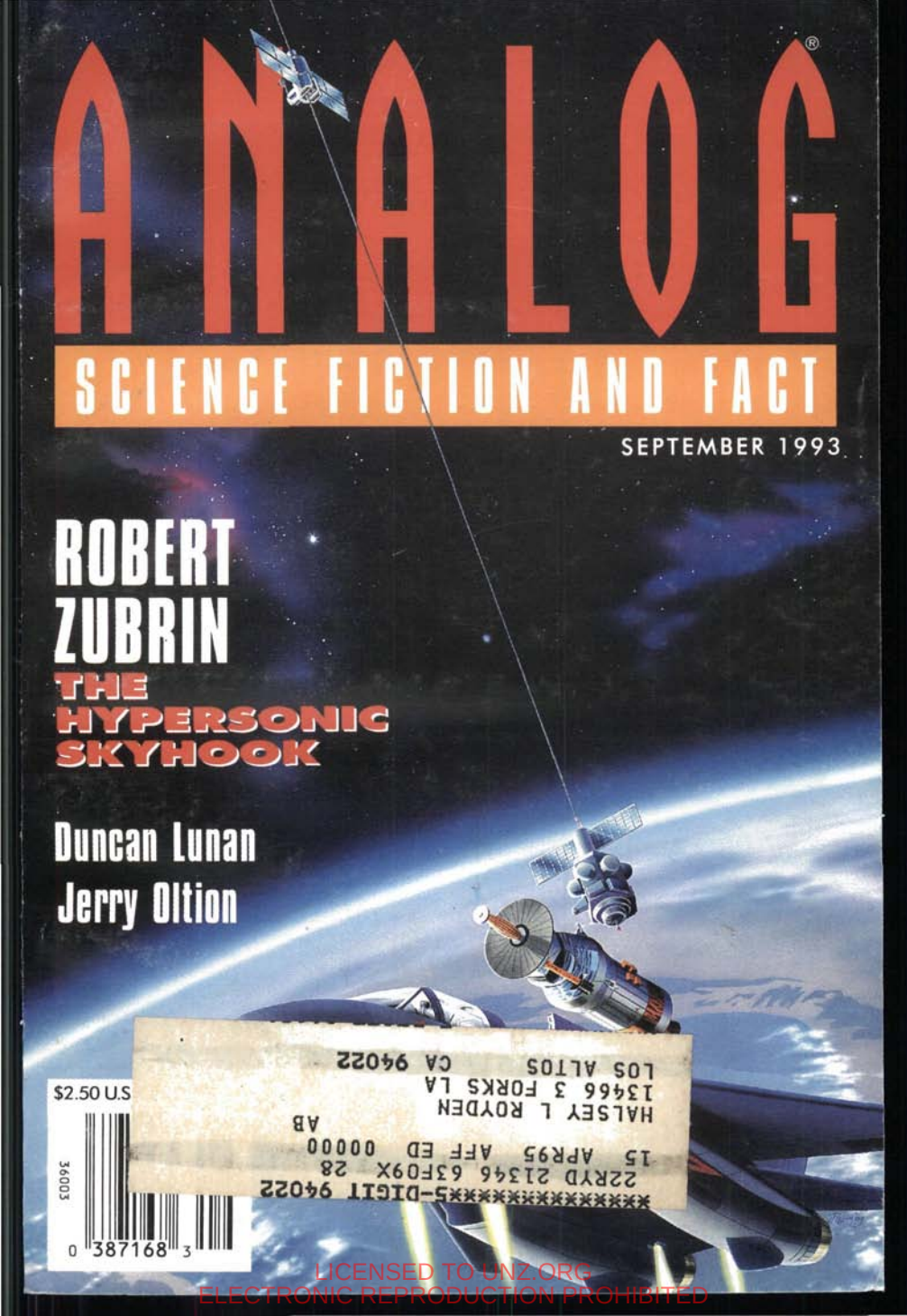

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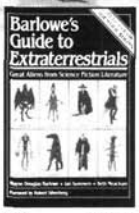

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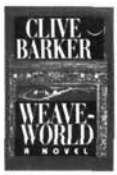

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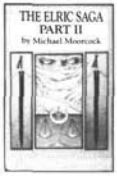

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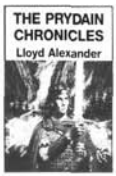

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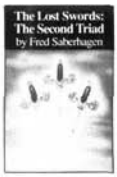

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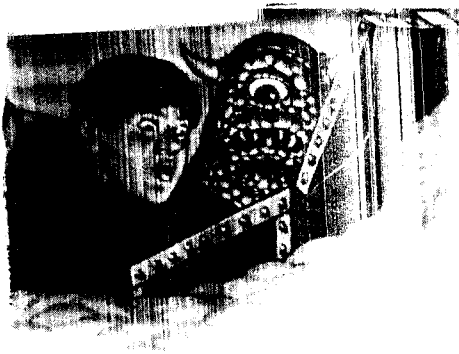

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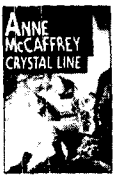

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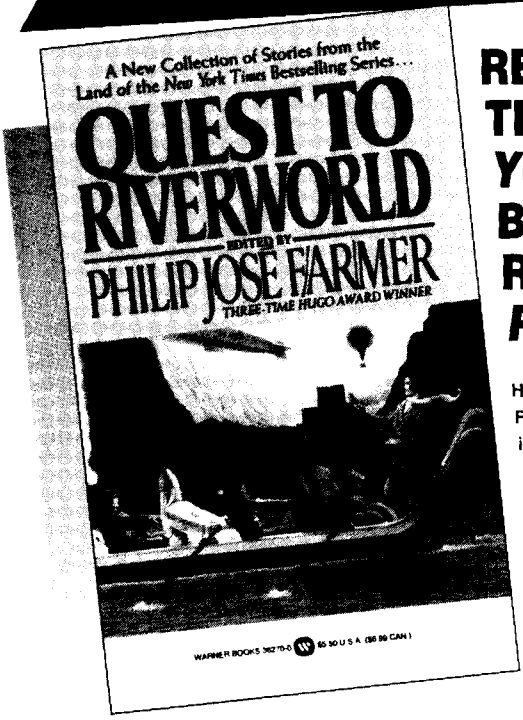
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EDITORIAL Stanley Schmidt

MAGIC

At last the end of Marvin's quest was in sight. Clambering up the icy ledge among brooding skeletons of trees, he saw the gnarled stump growing isolated out of weathered rock, its top cut flat and carved with the long-sought map. Soon the treasure would be his!

His triumph was short-lived. The writing on the map was in a language he knew not, and a sound as of distant thunder heralded danger from the west. A glance thither showed horses galloping over the rise, bearing his archenemy Skalawagh and his henchmen. What was Marvin to do? He couldn't read the map; and if Skalawagh saw it first, he would throw Marvin in his dungeons while he had the map translated and steal the treasure for himself!

"Might I be of assistance?"

Marvin nearly leapt out of his pantaloons at the sound of the voice behind him. He whirled to face an unknown yet oddly familiar man with a long gray beard and a cloak of swirling colors. Marvin blinked, and blinked again. "Aren't you the Wandering Wizard, famed in song and story?"

"At your service," said the Wizard, with a flourish of his cloak.

Marvin thought fast, then tapped the crucial spot on the map. "This treasure is rightfully mine. But I can't read this writing—"

"I recognize it," said the Wizard. "It's Jybberish."

Hope leapt in Marvin's heart, even as the hooves thundered closer. "Then you can tell me what it says?"

"Not I, forsooth. But my brother is fluent in Jybberish. He can help you." The Wizard produced an odd-looking box from a huge pouch at his waist. "I shall magically store its image, and Bob can translate it for you soon." He held the box near the map. It clicked and whirred, and he stuck it back in his pouch.

Marvin understood not, but then he could hardly expect to understand wizardry. "There is little time," he said. "Yonder evil horseman seeks to snatch the treasure from me. If he sees the map—"

"Then he must not see the map," said the Wizard, catching on at once. Producing a flask of magic potion

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from his pouch, he poured it over the stump. "Quickly!" he commanded. "Down the ledge. My carriage awaits without!"

As Marvin scrambled down the cliff, followed closely by the Wizard, the stump flared into towering flames, reducing the map to ashes. But Marvin drew up short when he saw the Wizard's strange carriage. "I didn't realize you meant without horses," *he said gloomily.*

"Trust me," said the Wizard with a Wizardly grin. "It's better that way."

And so it was. In a trice they were bouncing off along the crude road, leaving Skalawagh and his evil minions in the dust. Moments later they were barreling full tilt toward a sheer cliff face. Mouthing terrified prayers, Marvin braced himself against the inevitable crash.

"Open, says me!" cried the Wizard, and an open door magically appeared in the cliff wall. The carriage roared through into a deep cavern, and Marvin looked wonderingly back to see the door disappear behind them. The carriage slowed abruptly, with a marvelous wild squealing, and its doors opened (how else?) by magic. The Wizard and Marvin stepped out into a brightly lit, gleaming chamber of unknown wonders.

"That was great!" Marvin laughed. "But won't they follow us?"

"They'll try," said the Wizard with a shrug, "but they'll never breach that door. Nonetheless, if you're worried. . . ." He produced a magic wand from his pouch, tapped a mystic formula on it, and Marvin saw the land outside, somehow transported into a box on a table. It didn't look the way he'd always imagined a crystal ball, but he knew legends got distorted in the telling and retelling. . . .

In the magic box Marvin saw an approaching cloud of dust resolve itself into several very angry horseman, Skalawagh at the fore. "Watch," said the Wizard. Then he said, "Turn back, evil Skalawagh! Hie you hence with all haste, lest I blast you and all your men and horses to smithereens!" He said it conversationally, even casually, yet it reverberated all around them like a chorus of a thousand demons. Marvin cringed, but the Wizard turned to him with an impish grin, his voice again soft and normal. "It's even louder out there. I don't think they'll bother you for a while." He pointed at the magic box. "Look, they flee even as we speak! Now, let's have a look at that map of yours."

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He sat in his wizardly throne and motioned Marvin to a nearby chair. Reaching into his pouch, he pulled forth an exact replica of the map on the stump. Marvin asked nervously, "Your brother is here?"

"Oh, no!" the Wizard laughed. "He's on the other side of the world. But that's no problem for a Wizard." He picked up yet another oddly shaped wand from the table at his side, held it close to his face and spoke into it. "Hello, dear brother! Got a minute for a rush translation job? I've got a friend here in a spot of trouble.... I'll send it right over. Thanks!" With that he stuck the map copy into a slot in a box on the table. For a moment Marvin feared the box was eating his only copy of the map, but then it slid back out, good as new.

"Well?" he said.

"We wait," said the Wizard. "But not long." He gave Marvin a long look. "You look famished. Let's have a bite to eat while we wait." He opened another box, and the blast of cold air that emerged made Marvin suddenly aware of how oddly, cozily warm it was in here. The Wizard pulled two objects out, popped them into still another box, and mere moments later put a steaming, heavenly smelling tray in front of Marvin and another in front of himself.

Marvin stared in wonderment. Did his eyes and nose deceive him? Were these really fresh meat and vegetables, in the dead of winter? One taste told him the meal was exactly what it seemed—and deliciously prepared, too.

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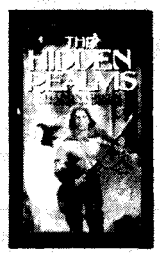

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"A little dinner music?" the Wizard suggested. At once the room was filled with the lush sound of a king's orchestra and a heavenly choir, though no musicians were to be seen.

Marvin dug in so ravenously he almost forgot why he was here—until a tiny bell tinkled and the wizard reached out to the box where he had earlier inserted his magical image of the treasure map. Now a new copy emerged, which the Wizard glanced at and then handed to Marvin. It was just like the old one, except now all the words were clearly written in ordinary language—and Marvin saw exactly how to find the treasure.

"Good enough?" the Wizard beamed. "All you have to do is this. . . ."

It certainly sounds like magic when you describe it that way, doesn't it? Yet every bit of the Wizard's magic is now available off the shelf to anyone who has enough money and the inclination to spend it that way. Each of his miracles is now so commonplace that we have an ordinary word for it, used and understood by everyone not in relation to fantasy, but to everyday life: Polaroid camera, gasoline, match, automobile (in such variations as car, truck, or van), voice-operated garage door, electric lights, central heating, television (with wireless remote), PA system, telephone, fax, freezer, TV dinner, microwave oven, CD player. And that list is a mere sampling of the arsenal we all have at our disposal.

"Oh," you may say, "those aren't really magic. Those are just gadgets." But ask somebody who lived five hundred years ago. Ask your own grandparents (or great-grandparents, depending on how old you are). Most of those things would still have been called magic, or something very close to it, even at the beginning of this century. Five hundred years ago, *all* of them would have been clearly, unequivocally, no-doubt-about-it *magic*, with no other explanation available.

Put it this way: if you'd shown up using any one of those things anywhere in the world at that time, you very probably would have been burned as a witch (or, if you were lucky, worshipped as a god).

The concept of magic essentially grows out of ignorance. By this I don't mean "Only Ignorant People believe in magic," but only that whether you call a thing magic depends on how well you (or at least somebody in your culture) understands it. If you see somebody doing something that you can't understand, and nobody you know claims to understand it either, that's magic. As soon as you understand it, or everybody can do it, it ceases to be magic and becomes mundane and taken for granted.

In the well-known words of Arthur C. Clarke (often called "Clarke's Law"), "Any sufficiently advanced technology is indistinguishable from magic." But there's also truth in Kallis's Corollary: "Any sufficiently advanced magic is indistinguishable from technology." If you don't know how to do it, it's Magic, and a proper subject for awe. If you do know how to do it, it's "mere technology," to be

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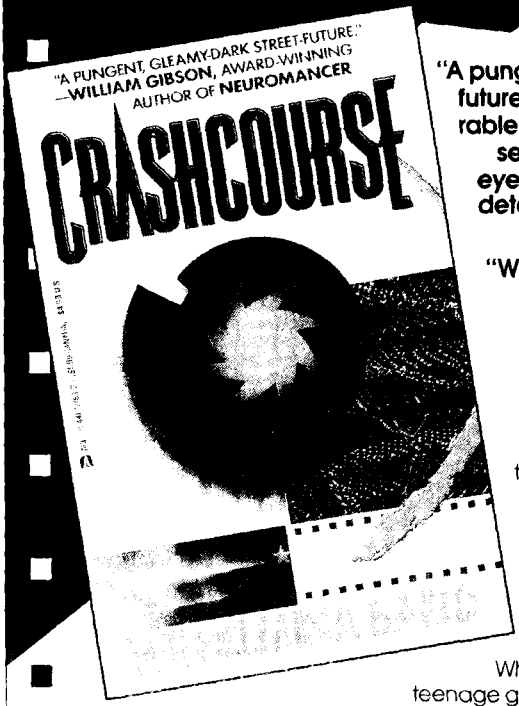

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When Moke and Dosh take in a teenage girl, Cass objects strongly. She's got a hunch the girl is an actress in the movie, "cast" to make sure that the three of them never collect the money that was promised them when they signed on the dotted line...

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shrugged off or even disparaged.

I was recently reminded of this when I was describing to someone the capabilities of the Trav-Tek computer navigation system (see my May editorial, "Test-Driving the Future") and a new camera I'd recently acquired. His reaction was, "Magic is not too strong a word"—and I realized suddenly that it isn't, and people need to be reminded of that occasionally.

By the standards and understanding of virtually everyone who has preceded us on this planet, *every one of us is a powerful wizard—not just figuratively, but literally.* Our everyday lives are just full of objects and actions that we consider unremarkable, but which our ancestors could at most imagine as miracles or sorcery.

What we tend to forget, having learned to take many of our ancestors' miracles for granted, is that this conversion process is by no means over. Forgetting that is particularly ironic when you consider that it's actually going faster now than it has ever gone before. Yet the very people who casually use today's state of the art seldom grasp the fact that tomorrow's will be quite different. We even have occasional people who actually work in some branch of science or engineering, or the history of those fields, telling us with straight faces that science and technology have done pretty much all they can, and all that's left is trivial refinements.

Oh, yeah? Where have we heard that before? Who was the famous physicist who said, "There's nothing left for the next generation of physicists to do but measure the next decimal place"—right before relativity and quantum mechanics turned the field upside down?

We don't know what, if anything, the next comparable revolutions will be—but we don't know that there won't be any. Nanotechnology doesn't qualify, at least as foreseen by K. Eric Drexler and the many other researchers who are now working in that direction. Nanotech, if it develops, will be a revolution of several orders of magnitude in engineering, but not in science. The kinds of arguments Drexler has used to foresee its possibility are quite conservatively based in well-established science. Nevertheless, there are scientists who see even that as "fantasy" magic. It is not inconceivable that they'll turn out to be right—but the historical record for predictions of impossibility does not encourage taking them too seriously. Just look at the state of electronics in general, and computers in particular, a mere 25 years ago. How many people either in that field or in science fiction came even close to foreseeing the present state of affairs?

And, of course, major surprises—the kind of truly revolutionary breakthroughs that can't be foreseen, like relativity and quantum mechanics—are still possible. Yes, we may someday reach a point where there are no more of those to be found. It's even conceivable that we're already there. But don't count on it. If science fiction restricts itself to rigorous extrapolations of things

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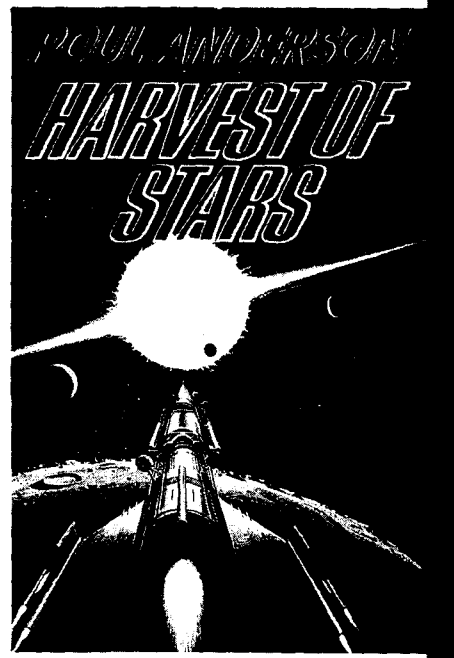
Poul Anderson

HARVEST OF STARS



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we already know, it may be fooling itself and shortchanging its readers in a big way. As Poul Anderson once said (at least approximately), "The purest fantasy of all may be what's normally thought of as the hardest science fiction. What could possibly be more fantastic than the idea that we already have all the answers?"

Certainly it is part of the business of science fiction—a very important part—to look at the implications of what we already know is likely. But it is no less important to try to imagine those things that we would call magic, but will be commonplace a few centuries—or decades—hence. ■

IN TIMES TO COME

In the early days of science fiction one of the most popular topics was the exploration and colonization of our Solar System. In the early days of *actual* exploration of the Solar System, science fiction writers seemed to shy away from setting stories on our local planets, perhaps out of fear that new data would make their stories obsolete before they saw print. But then came a third phase: as planetary probes rewrote most of our ideas about neighboring planets, some fiction writers began to realize that the new knowledge opened up a wealth of new possibilities. The Solar System had, in effect, become a whole new place.

A few years back, Grant Callin began working his way systematically through the "new" Solar System in a series of stories set on each planet (or comparably important region). It's been a while since the last of those stories, but our October cover novelette makes a fine return to it. This one is "The Carhart Shale," wherein an explorer on the new Mars makes an exceedingly important discovery at an exceedingly inconvenient time. Sometimes research takes a *lot* of dedication!

Our fact article will survey the work of some dedicated researchers in our own world and time. By Richard Terra, it's a progress report on what's been done in the last few years toward making nanotechnology a reality. And rounding out the issue we'll have a mixed bag of tales by such writers as Grey Rollins, W.R. Thompson, Doug Beason, and Jerry Oltion.

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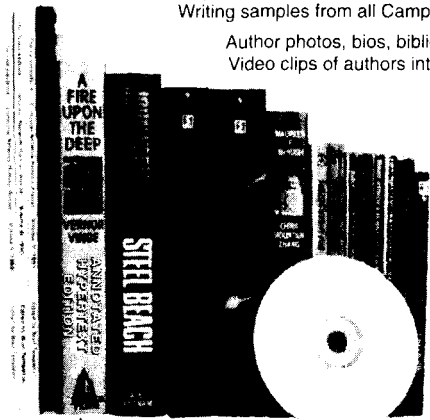

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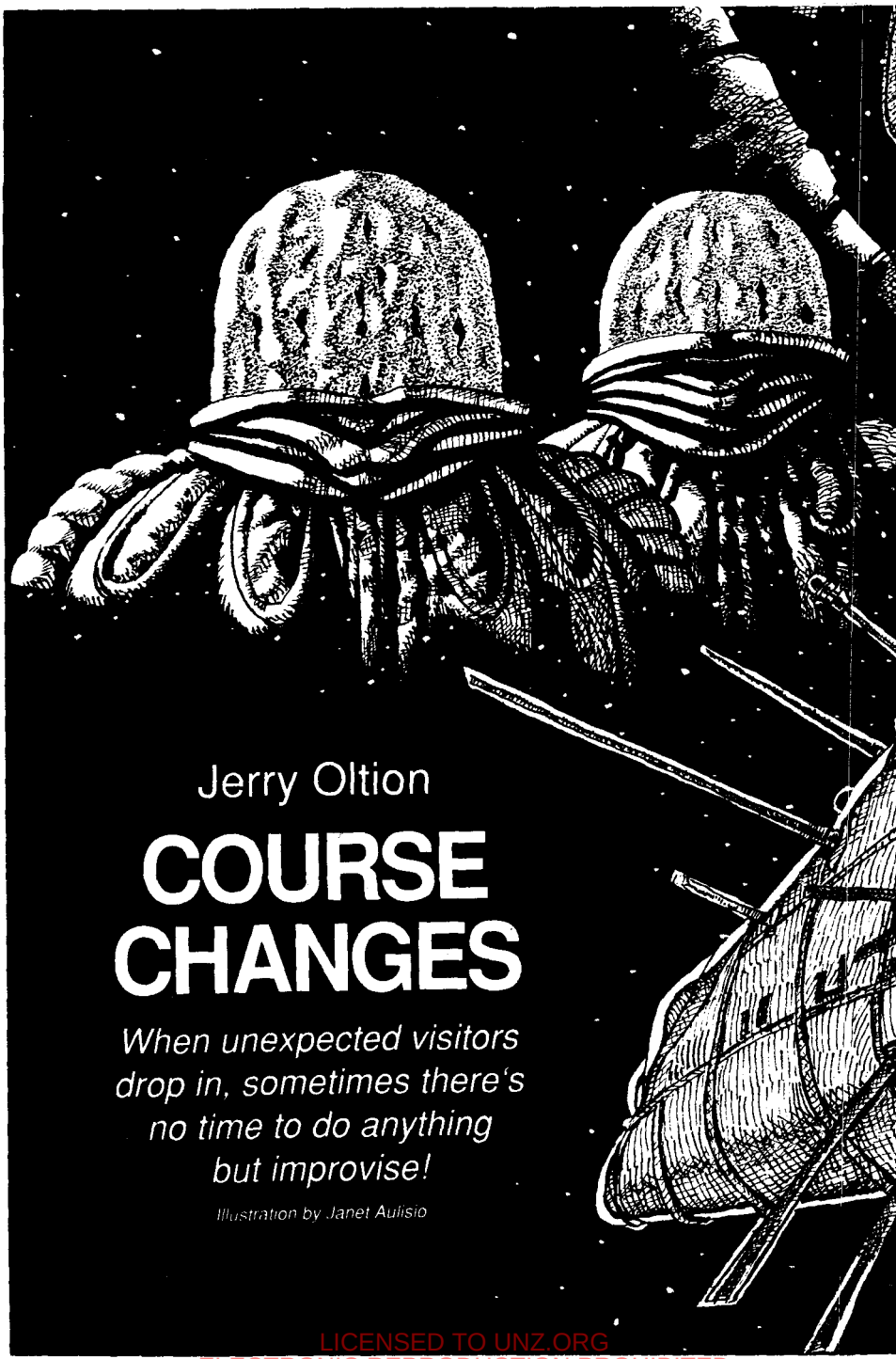

Jerry Oltion

COURSE CHANGES

When unexpected visitors drop in, sometimes there's no time to do anything but improvise!

Illustration by Janet Aulisio

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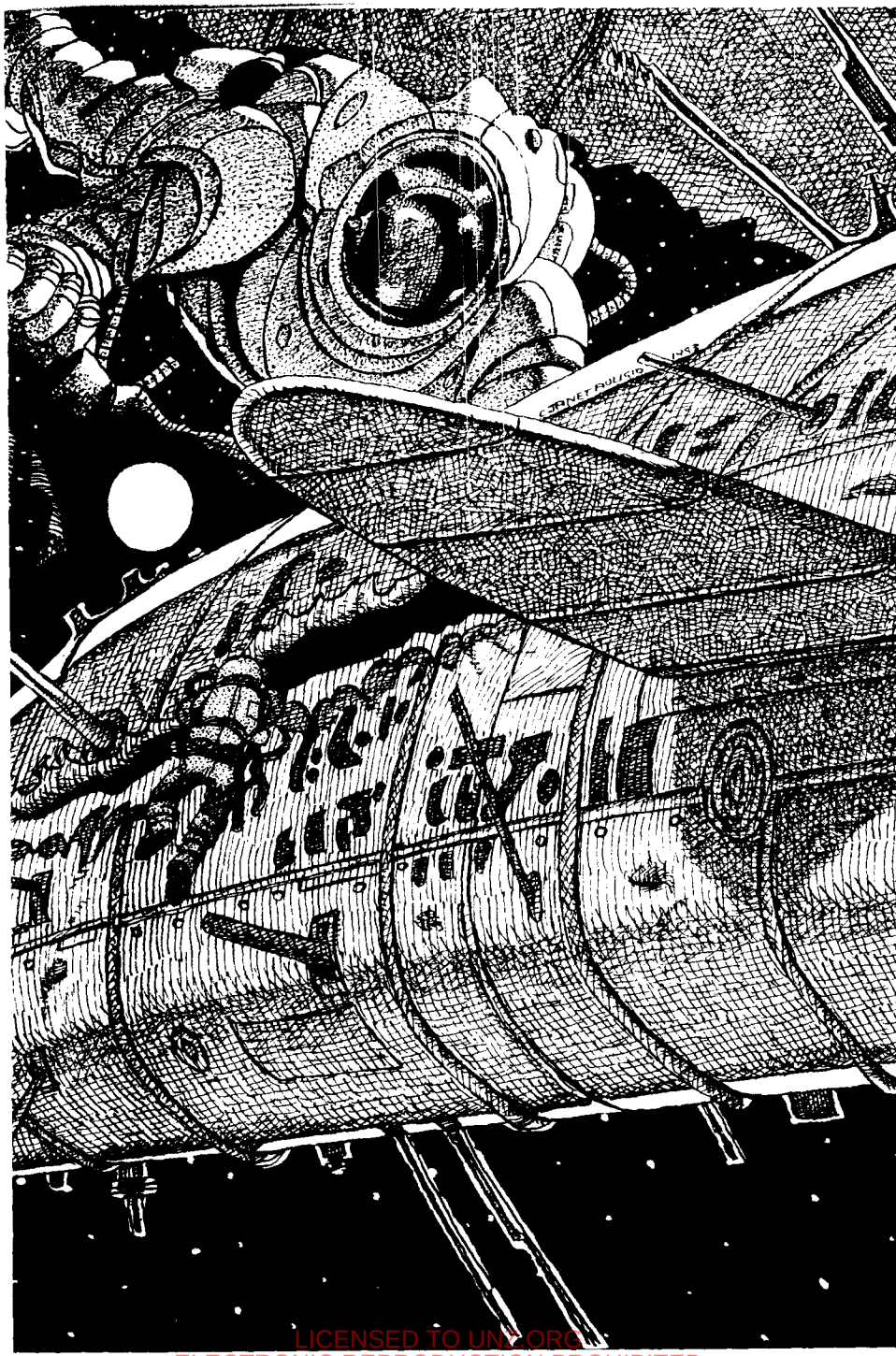

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The magnetic pulse came without warning. One moment the cramped quarters of Lenard's research ship hummed with purposeful activity, dozens of instruments mapping the faint magnetic fields in the outer Solar System, and the next moment it was all sparks and tripped circuit breakers and wailing alarms.

Cursing, he dived headfirst through the hatch between the control and science decks, flipped off the master power switch for the smoking component rack, then yanked a fire extinguisher from its clamp and hovered with it over the ruined electronics until he was sure nothing was going to burst into flame. The smell of fried insulation made him cough and his eyes watered from the smoke, but he held his breath and bent close to see what had actually burned.

It didn't take long to find the culprits: it looked like the magnetometers mounted on the instrument platform outside had received a pulse powerful enough to burn out the delicate first stage amplifiers. Where the pulse had come from was a mystery, though. The detectors were extremely sensitive, but it would take a magnetic field of at least a few gauss to overload one, and the nearest source of a field that strong—Saturn—was over a billion kilometers away. Besides, Saturn didn't pulse.

Lenard suspected something closer to home. The ship's own electronics could produce a strong enough field. They were supposed to be shielded, but maybe a motor or a heating coil somewhere had been overlooked.

Satisfied that the danger of fire was over, he pulled himself back up-ship to the observing controls and reviewed the data leading up to the event. The detectors were highly directional, and in the milliseconds before they failed they had recorded the location of the pulse: not Saturn, nor from the ship. It came from even farther out of the Solar System than either, and a few degrees out of the plane of the ecliptic.

The instrument package on the outer hull carried an optical telescope as well as magnetometers; Lenard aimed it at the right patch of sky and found a new star in the field. It was very faint at first, near the telescope's seeing limit, but by the time he could reprogram the optics for an infrared scan it increased by a full order of magnitude.

It had to be a supernova. Nothing else he could think of could grow that much brighter so quickly. And the magnetic pulse could only mean he had detected the explosion itself. He'd never have believed a nuclear EMP could be detected over interstellar distances, but he couldn't see what else it could be.

He could hardly believe his luck. To witness the birth of a supernova was something every astronomer since Galileo had practically lived for, and here was Lenard Dennison, halfway into interstellar space with a whole shipload of measuring equipment, catching the very first signals. Some of that equipment no longer worked, but enough of it did to ensure him a place in the history books.

He set every surviving instrument on board to record the new source,

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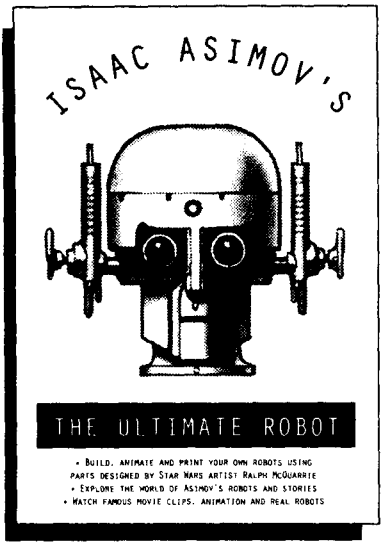
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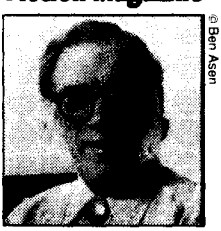
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then got on the radio to Earth. They were nearly two hours Sunward of him; still unaware that anything unusual had happened. There was no way his message could beat the supernova's wave front there, but he could at least let people know what was going on, and remind them that he'd seen it first.

An hour later he was beginning to regret his hasty message. Something strange was happening to his supernova. Its brightness was still increasing, but its spectrum was that of an ordinary yellow star, blue shifted and varying in magnitude with a period of about thirty seconds. Other than the increasing brightness, it had none of the characteristics of a supernova.

He spent a minute chewing off a fingernail and staring at the spectrum, then he called up the Sun's spectrum on the computer and compared the two. They matched on all points, except for the huge Doppler shift. He was seeing reflected light, then, off an object within the Solar System, and moving fast.

Why hadn't he seen any proper motion, then? Anything that moved at the kind of velocity that this did should show motion against the stellar background. Lenard compared the object's original coordinates against its current ones and was relieved to find that it had indeed moved, though not as much as he'd expected.

The navigation computer had a program for calculating an object's trajectory. He fed it the data, then did it again when he didn't believe the results the first time, but the answer came out the same. The object was headed toward the inner Solar System at nearly ten million kilometers per hour—and it would miss him by only a hundred thousand kilometers. That was less than the distance from Earth to the Moon.

Lenard let himself drift over the controls while he thought about the implications of that. He was halfway between the orbits of Saturn and Uranus; nothing belonging to the Solar System could move any faster than a few kilometers per second out there or it would fly right on out into interstellar space. But here was something coming toward him at a couple of hundred times that speed. He could see only two possible explanations: either it was a spaceship—and a damned fast one—or a piece of interstellar matter, something that had never been in the Solar System before. Given the enormous magnetic pulse that had accompanied its arrival, Lenard guessed it was both.

He had about two hours before it passed. He used that time to launch a probe carrying a video camera and a high-resolution stroboscopic camera toward the object's path. There was no way the camera package could reach it in time, but it could at least shave off most of the distance and get a few good pictures of the thing as it flew by.

While the probe accelerated toward the meeting, Lenard tried hailing the spaceship—if that's what it was—by radio. When that got no response he tried flashing a laser at it in sequences of prime numbers. He even tried pulsing the magnetic core

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of the fusion drive, but the object didn't react to his signals. Finally he turned the radio antenna toward Earth and told them to stand by for something even stranger than a supernova, then fidgeted while he waited for the pictures.

The object was just a speck of light at first, growing brighter and drifting slowly across the stars as it drew near. The probe's camera panned with it, barely keeping it in frame as it became a white streak against the stellar background, then disappeared in the glare of the Sun. Lenard backed up the image until the streak was onscreen again and noted the time displayed in the lower right corner. He recalled the corresponding frame from the stroboscopic camera and put it alongside the first.

The object's speed had blurred even that picture, but it was unmistakably a spaceship. Unlike Lenard's ship, which had never been designed for atmospheric use, this one looked like a single-stage-to-orbit shuttle, with short, stubby wings set far back along the fuselage and no windows except for two in front for the pilot. It was painted white and had lettering on the hull, but not in any alphabet Lenard was familiar with. He was willing to bet nobody else in the Solar System would recognize it either.

He noticed something else about the ship: It had a gash torn diagonally along the fuselage just in front of the left wing, a strip so cleanly cut that he hadn't noticed it at first as something wrong. But now he could see the twisted metal at the edges, and the way the lettering on the hull was wrinkled and stretched. Something had hit it.

He ran the camera back and watched the ship approach in slow motion. It spun as it came at him, tumbling end over end about one revolution in thirty seconds. There was no sign of corrective attitude rockets, no sign of life at all save for a soft glow coming through the windows. The ship still had power, at least.

He switched to the real-time image. The probe's camera was still staring right into the solar disk. Lenard felt a sudden chill run up his spine as he realized what that meant. The alien ship was falling straight toward the Sun.

Any fear he felt about meeting mankind's first extraterrestrials vanished in that instant. Nobody was going to meet these guys. Any survivors were going to fall screaming into the Sun at a speed no human had ever traveled, and there wasn't a thing anybody could do about it. There was no way anyone could match velocity with the thing. The Solar System wasn't that big; anybody who started after it even from the asteroids would hit the Sun long before he got up to even half the alien ship's speed. They'd have to start from clear out by Saturn, and even then they probably wouldn't have the fuel to slow down again once they reached it.

Lenard realized who his hypothetical "they" had to be. He was the only person anywhere near the right place to even make an attempt. He had over two billion kilometers to catch it in;

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at the aliens' speed he would have about two hundred hours to do it. Two hundred hours at full thrust—in his case just one *g*—would give him about three times the alien's velocity, but simply accelerating all the way wouldn't accomplish a rendezvous. He would have to accelerate to catch up, then decelerate to match the ship's velocity, then accelerate again sideways to keep from falling into the Sun along with it. Plus he would have to cancel out his own orbital motion in the process. Whether or not he could accomplish all that was a tougher question.

The answer the navigation computer gave him was better than he'd expected, though not as good as he'd hoped. With the fuel he had left after his trip outward, and if he could dump enough mass to give him another three-hundredths of a *g* of acceleration, he could match velocities with the alien just outside the orbit of Earth. That would give him about sixteen hours before they both dropped into the Sun. To stay far enough away to keep from being fried, he would have about three hours to dock and help any surviving aliens salvage whatever they could from their ship. Then they would have to blast laterally and whip around the Sun in a tight parabola which would fling them off toward interstellar space again at the same velocity they'd come in with.

There was the rub. Lenard had fuel enough to reach that velocity, but not to brake again once he rounded the Sun. He would have to count on someone else to come pick him up and hope *they* could slow down enough afterward to stay in the Solar System. If not then another ship would have to rescue them both, and maybe another one after that, each one shedding a little more velocity until they finally managed to reduce it enough to allow a return to home. They might wind up abandoning a couple of ships before this was all over with.

The worst part for Lenard was knowing he didn't have time to check with Earth first. Speed-of-light lag would make it four hours before he could get any reply to his message, but by then the alien ship would be beyond his reach no matter how hard he accelerated.

He was gearing himself up to make a life-or-death decision when he realized he was psyching himself out for nothing. He could start his pursuit, and if nobody could come after him then he could always abandon the chase before he used too much fuel to stop again. Either way it would mean dumping the observation instruments and most of his personal belongings, but that was really the worst that could happen. Besides, his magnetometers were burned out anyway. With a sigh he hoped could be heard all the way back to the science foundation that had funded his trip, he unlocked the protective cover and pressed the switch that unlatched the instrument package.

He spent a few minutes rounding up everything he'd let drift free during the last few days in zero *g*, jettisoning everything he could live without and tying down what he needed,

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then strapped himself into his acceleration couch, called up the course the computer had calculated, and lit the drive. Weight settled onto him as the fusion engine built up to full thrust.

When he was sure the drive was running smoothly and the ship was aimed right, he got on the radio again and told Earth's space traffic controllers what he was doing. He transmitted all his stored data, from the first magnetic pulse to the real-time radar image, in the hope that they would believe him, then settled back to wait for their reply.

Their first response was simply, "Message received. Stand by." Lenard envisioned the scramble going on as junior operators called more senior operators, who no doubt called people more senior to them until the news reached someone capable of committing the resources necessary for a rescue. That would almost certainly have to be someone military. Lenard scowled at that; he didn't have a whole lot of use for the Space Authority. In his opinion, military attitudes didn't have any place in space. But they did have the most capable ships. Maybe just this once he could put up with them.

He expected at least another hour's wait, but was surprised when only half that passed and the radio hissed to life again as a deep, authoritative voice said, "Lenard Dennison, this is Commander Donald Parker of the Solar Space Authority. We agree with your analysis, and support your present action. We're working on an optimum course for you, and we'll transmit modifications to your current flight profile as conditions warrant. We're searching our database for a suitable rescue vessel, but we're confident we can chart a solar flyby that will put you in somebody's path."

Parker cleared his throat, then said, "The data you sent would seem to indicate some form of faster-than-light propulsion. We believe the magnetic effect you recorded may have marked the transition from 'hyperdrive' to normal space, and the damage to the alien ship may have come from a meteor impact after it materialized in our Solar System. Depending on the condition of the crew, your primary objective should be to secure the hyperdrive engine, then any other technology or information you can recover.

"We will have more . . . ah, suggestions as the mission progresses. Parker out."

Lenard smiled out at the stars. "Suggestions." Sure. Orders by any other name would rankle as deep. And now he was on a "mission," was he? Well, Parker would find out how far he could push a private citizen if he tried to order Lenard around like a soldier.

For now, though, Lenard agreed with his assessment. The alien ship came from interstellar space; its velocity made that certain. But even at ten million kilometers an hour it would take centuries to travel between stars, and it just didn't look like a ship designed for long duration flights in deep space. Its wings and streamlined body were built for take-

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offs and landings in atmosphere, as if the rest of the trip were incidental. If that was the case, then the ship had to have come from wherever it did faster than light.

Humanity had been aching for that capability since before the advent of controlled fusion. If Lenard could bring home even a clue toward how to build such an engine, he could name his price. That thought kept him on course, accelerating straight for the Sun, long after his fuel tanks passed the halfway mark.

He caught up with the alien ship near the orbit of Earth. Earth itself was almost two-thirds of the way around toward the other side of the Sun—still fourteen light-minutes away—but Parker had solved the communications problem by launching himself on an intercept course that would cross paths with Lenard while he investigated the ship. Parker couldn't hope to match velocity with them, but he'd arranged his flyby so he would be only a light-minute and a half away when Lenard reached the alien and that distance would dwindle to practically nothing as they swept past him. He could direct the investigation from there, or so he believed. Lenard didn't fight it; he figured he could always switch off the radio if the guy got too pushy.

The alien ship hadn't responded to any of his broadcasts, not even when he had closed in to within visual range of it. Lenard didn't know if they didn't use the same kind of communications equipment as humans, or if their radio had just been damaged in the accident, or if there was nobody left alive to respond, but he supposed he would soon find out.

He was already in his spacesuit—Parker's "suggestion" in case the aliens fired on his ship. So as soon as he brought the ship to a stop relative to the alien, he unstrapped himself from the acceleration couch and dropped down through the science deck to the service deck, where he clipped his tool belt around his waist and cycled through the airlock.

"I'm outside," he said as soon as the outer door opened. His suit was set to relay both audio and video to the ship, and from there to Parker and to Earth.

The Sun was a harsh glaring inferno to his left. It was no bigger than it normally looked from Earth, but the knowledge of how fast he rushed toward it made it twice as large in Lenard's mind. It would *be* twice as large in just a few hours, and larger still before he swung past it.

He looked overhead to the alien ship, which was still tumbling slowly end over end about a hundred meters away. Now that he was close to it he could judge its size: he guessed it was about thirty meters long and ten high. About half again as big as his own ship. "Still no sign of life," he said. "I'm going to jump across."

He kicked off against the hull. His tool belt held a rocket pistol for maneuvering in space, but he'd jumped straight enough that he didn't need it. The hundred meters narrowed to nothing and he grabbed for a rung on the hull near the base of the wing as it swept past. The center of the ship

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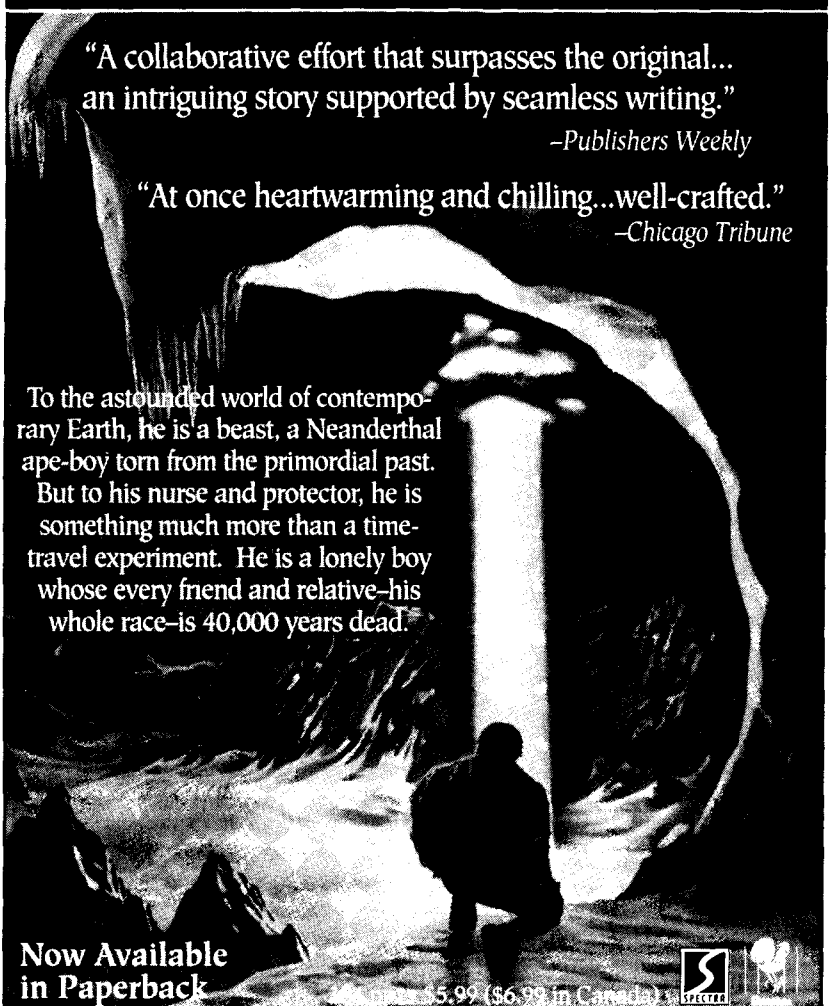
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suddenly became "up" for him, but the force was only a fraction of a *g*.

"Well, it's not made of antimatter," he said, just as Parker said, "Collect any loose material you encounter and put it in a pocket just in case you have to make a fast retreat."

Lenard looked for some, but the expanding cloud of debris that usually accompanied a decompression accident had blown away by now, leaving the ship and the space around it free of flotsam. "Nothing to pick up on the outside," Lenard said. He climbed up toward the opening torn in the hull. "I've reached the gash in the side. It doesn't look like a meteor strike. More like explosive damage. The edges of the opening look melted, and they've been blown outward either by the explosion or by air pressure when the thing decompressed. I'm going in."

He had to slide in sideways, a little like squeezing between the wires of a barbed-wire fence. A *lot* like that, he realized. The edges were just as sharp, and though his suit was woven of Kevlar, Lenard didn't want to snag anything vital. He slid through a wide spot near the center of rotation and reoriented himself to the floor. What was left of the floor, anyway. The explosion had torn up a pretty good stretch of that, too.

He didn't need his helmet light; a soft white glow came from what looked like random patches of the ceiling. Lenard wondered why the random pattern, then realized that the dark areas had probably been damaged in the explosion.

"Be careful of those edges," Parker said after he was inside.

Lenard grinned. Parker was receiving his transmissions over a minute late, and his response took just as long to return, too late to do Lenard any good. But he'd insisted on making his flyby, and he *was* sending a rescue ship to meet him on the other side of the Sun, so Lenard was willing to humor him. And Lenard was just honest enough with himself to admit that a human contact—even one over a light-minute away—was a welcome thing when exploring the unknown.

Panning around so his helmet camera would transmit what he was seeing, he said, "I'm already through. It's built quite a bit like something we might design. There's a floor that must divide the ship roughly in half longitudinally. I'm in the top half, in what looks like a cargo hold. It looks like it must take up most of the space. It's packed about three-quarters full with boxes, and they're all tied down with a net stretched across the front of 'em. They all look to be the same size, cubes about a meter on a side.

"I don't see any sign of crew here but there's a bulkhead with a door in it leading forward, and a hatch in the floor beside it." Rather than open the hatch he just pushed himself down to look through the gap torn in the floor, but he had to turn on his helmet light to see beyond it. There was no light in the bottom half of the ship

His spotlight reflected off a maze of hoses and wires and squat, bulky masses of metal. "The bottom half of the ship looks like just one big room, and it's all machinery. No sign of anyone in there, either."

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He straightened back up and looked toward the door leading forward. The control room had to be beyond it. He was just about to kick off toward it when Parker's voice stopped him.

"Give me a better look at that damage in the floor."

"You're interested in the *floor?*" Lenard asked, but as long as he was there he tilted his head downward again and panned back and forth along the wide gap torn in the deck. Now that he was paying attention to it he realized that the edges of this one were much cleaner than the breach in the outer hull. It looked like something had sliced cleanly through it, rather than melted its way through. The floor wasn't nearly as thick as the hull; maybe that had something to do with it.

"Give me a look farther down inside, too," Parker said, and Lenard obligingly bent down and gave him another view of the engine room. A lot of the hoses and wires were also cut, and one of the heavier pieces of machinery had been half melted. Lenard backed up until his head was near the gash in the outer hull and sighted straight through the one in the floor to the damage farther down.

"OK, I see what you're getting at," he said. "Some kind of laser beam or something did this. Somebody shot at them. You can tell me what you think about that while I go look and see if anything is alive up front." He switched off his helmet light and kicked off toward the forward door. Coriolis effect pushed him up toward the ceiling, but he bounced off it with his hands until he reached the bulkhead and could grab a handhold. Spin-gravity made it the floor now, but the force was hardly enough to hold him in place.

"Zoom in on that engine," Parker said, then a moment later when Lenard's signal caught up with him he said, "All right, but I want a better look at it in a minute. As for what I think about it, I think we'd better find out as much about their weapons technology as we can. If whoever shot at them comes looking for them, we could be their next targets."

"Maybe," Lenard said. He wasn't convinced. Military people were always quick to see a threat in any new situation, whether one really existed or not.

True to form, Parker said, "When you go through the hatch, take it slow and keep your hands in plain sight. If anybody's still alive in there they're liable to be good and spooked, and they may shoot at anything that looks dangerous."

"Wonderful," Lenard said, but he supposed Parker was right. *He* would certainly be spooked if an alien came on board his ship, and he hadn't even been shot at. Yet.

The door had no handle, just a blue light on the left side of it about chest high. Lenard held himself against the wall even farther to the side and touched the light with his hand, and the door slid away into the wall to the right.

No air rushed out, nor did anyone shoot. Lenard cautiously held first one hand, then both out into the doorway. When nobody shot at

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those, either, he pulled himself forward and looked through into the forward section of the ship.

It was the control room. Its ceiling glowed just like the cargo hold's did, and in its soft light Lenard saw two small acceleration couches facing the front windows, with a bank of instruments wrapping around them and covering the ceiling as well. The couches were both turned away so he couldn't tell if anything sat in them, but he watched them for a moment and nothing moved.

Sunlight sprayed in through the windows as the ship tumbled, silhouetting the loose debris that had fallen on them in the faint spin-gravity and sweeping aft across the ceiling, spotlighting Lenard for a second, then gliding forward across the floor and out again.

He blinked until he could see again and took stock of the cabin. Behind each chair was a fold-up table about the size of a serving tray. The left one was down; the right one was stowed against the wall. Beneath the right one was a cot about half a meter too short for human use, and beneath the cot was a storage locker. On the left side stood a short box with a handle on it that looked for all the world like an apartment-sized refrigerator, and beside that was a chair with a tight-fitting lid. On a human ship it would have been the toilet, and Lenard guessed that's what it was here, too.

He said, "I thought my ship was cramped, but this place is downright claustrophobic. More like the cab of a truck than an interstellar spaceship. I wouldn't want to spend more than a day or two in here."

He leaned in through the doorway and raised his head up near the ceiling. From there he could see what might have been arms dangling straight ahead from the right chair. "One of the couches looks occupied," he said. "I'm going forward."

This was the moment he'd been alternately dreading and anticipating since he'd begun the chase. He lowered himself through the door until he stood on the back of the empty chair, then kneeled down and looked over it at the occupant of the other one.

He'd thought he was prepared for the sight. He'd dreamed of so many horrible shapes the aliens could take that he was sure there could be nothing in the chair worse than what he'd already faced—and in that he was right. It wasn't as bad as he'd feared, but he'd been hoping for better.

The alien would have come up to Lenard's chest if it had been standing. It had two stubby legs and a thick, barrel-shaped torso, with two arms that stuck out lower than they would on a human. The arms ended in a four-way claw that looked as if all four digits were mutually opposable. It didn't have much of a neck, just a bulge on top for a head, and that was mostly wrinkles with vertical slits scattered apparently at random over it. At least three of the slits glistened with something wet or bony behind them, but decompression had swelled them shut and Lenard couldn't tell if they were eyes or something else.

Sunlight swept through the cabin

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and momentarily blinded him again. Lenard let out the breath he'd been holding and forced himself to inhale another. "Good God, we're going to have to learn to get along with *that?*" he whispered.

When Parker spoke, it was to reply to Lenard's earlier comment. "The pilot may not have to spend more than a day or two in there, if the faster-than-light drive is instantaneous or nearly so. Even if the magnetic effects force him to come and go from a long ways out in a star system, at the speed he's traveling he could get wherever he was going in—oh boy. He's certainly alien, isn't he?" He paused, then said, "Let's hope we *can* get along with his kind, because they're way ahead of us technologically. Not just hyperdrive, either. From the obvious up-and-down orientation of that control cabin, I think they must have artificial gravity, too."

Lenard looked away from the alien. Parker was right; everything in there was designed to be used in gravity, and it couldn't have been from thrust, either. The floor ran the wrong way for that. If the ship didn't have artificial gravity then the pilot would be clinging to the walls every time he fired the engines.

"If they did, it failed when they got shot," he said. "I'm in free-fall now."

"There's no helping the alien," Parker said, "and we don't have forever. Grab what you can out of the control room, then go aft and have a look at the cargo."

No, they didn't have forever. The Sun swept past again, and this time Lenard squinted and looked out at it. Was it bigger than before? Or course it was. He'd been on board maybe half an hour, so he was five million kilometers closer.

It was time to start collecting goodies. First he made a slow scan over the control board so his camera could record the layout, being careful not to touch anything. With an alien control panel he could probably blow himself up just as easily as he could switch out the lights, but maybe the arrangement or number of switches and dials would help the engineers who would eventually wind up studying whatever artifacts he brought home.

When he was sure he'd recorded everything, he pulled a thin nylon mesh bag out of a pocket in his tool belt and began tossing things into it, starting with the debris that had fallen to the window. Pens, scraps of shiny paper covered in scribbles, a flat rectangular thing with buttons on one side that might have been a book or a computer or both—everything went into the bag.

He backed up and opened the refrigerator, swept everything into the bag without stopping to examine any of it—even the stuff that had boiled dry in vacuum—and moved on to the locker beneath the bed. There would be plenty of time to figure out what he'd grabbed once he got home with it; now he just wanted to get as many alien artifacts as he could.

When he'd taken everything he could remove easily from the control room he moved back into the cargo hold and opened one of the boxes there. It was made of some sort of

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plastic, but his knife sliced through it easily enough. Thousands of tiny gray spheres the size of marbles floated free when he lifted the top off. They were soft to the touch; Lenard thought they were just packing material, but he dug all the way to the bottom of the box without finding anything else.

"Drugs?" he asked as he took a sealable bag from his tool belt and filled it with the spheres. He tied it off and tossed it into the net bag with the stuff from the control cabin, then moved down to the opposite side of the cargo bay and tried another box. It held the same tiny spheres.

"Who knows?" Parker said. "Bag some up, then go below and check the engines." The time lag was getting less now as the fast-moving ships approached him. It was a good reminder of the time limit: when the lag approached zero, it would be time to go.

Lenard moved forward and touched the glowing sensor beside the hatch in the floor, figuring he'd go through that rather than through the sharp-edged hole. When it slid open he switched on his helmet light, grasped the hatch frame, and pulled himself through feet first, not bothering with the ladder. He found himself in an open space surrounded by machinery. Unlike the upper deck, this part of the ship had stuff bolted to the ceiling, walls, and floor alike. In fact, without the hatch in the ceiling, Lenard would have been hard pressed to say which side was "up."

"It's definitely not designed for artificial gravity here," he said. He looked for anything he could recognize, saying, "I'd sure like to know what's what before I start ripping things loose." He shined the light toward the aft bulkhead, where four massive hulks of machinery were bolted in place and braced with beams angled to the outer hull. Those were most likely the regular engines, Lenard supposed, though if they were fusion rockets then they didn't look like the kind his ship used. His ship had a single engine mounted outside the hull, and it was lot smaller than this one. Even accounting for the larger size of the alien ship, it looked like it had more engines than it could use. Of course, with artificial gravity, maybe they *could* use them. Maybe this ship could pull dozens of *g's*.

Parker said, "They've got to have it, though. That and the hyperdrive and any weapons you can find are top priority."

Lenard laughed. "If you can tell me what they look like, I'll be glad to bring them home for you."

But even as he said that, he realized he was looking right at the hyperdrive. He'd missed it at first because it was so big. It was an enormous egg-shaped mass, easily ten meters long and six or seven wide, built into the ceiling and festooned with stubby projections radiating in all directions. It looked tailor-made for generating an omnidirectional force-field around the ship, which Lenard supposed warping space might require.

It would be impossible to cut free in the couple of hours he had left, and impossible to fit in his own ship even if he managed it. The best he could do would be to remove as much

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hardware from it as possible and hope engineers on Earth could guess what was missing.

"Hah, very funny," Parker said. "Just bring home anything you don't recognize."

"It's not going to be that easy," Lenard answered.

He spent the next two hours cursing and sweating while he unbolted or simply pried loose anything he could budge from the engine room walls. None of his wrenches quite fit, but he was able to make do in most cases and he used a torch to cut through the bolts he couldn't unscrew. Most of them spun loose clockwise, but a few of the smaller, more delicate-looking devices were secured by bolts that ran counter.

"That alone tells us something about the people who built the ship," Parker had said when Lenard encountered the first of those. "It tells us they trade for goods with other cultures, and they've got enough commerce to make it worthwhile for one nation or world or whatever to make parts for another one's spaceships. That's encouraging. They're not all fighting wars with each other."

Lenard had just grunted something noncommittal at the time, but later when Parker said, "You *still* haven't found anything that looks like a weapon?" he said, "Hey, I thought you said they weren't all fighting wars. Maybe this is just a regular freighter."

"Then why did somebody else shoot it?" Parker replied after only twenty seconds or so. Lenard and the interstellar ship were drawing closer to him. His signal was filling with static, though, as his own velocity brought him in line with the Sun. Lenard had asked him why he didn't thrust sideways until the Sun wasn't in the way, but Parker had simply said, "We've determined this is my best course. Besides, *my* reception is just fine, and that's what's important."

So Lenard lived with the static the same as he lived with the constant harangue about weapons. It wouldn't last much longer anyway; in a half hour or so Parker would flash past him and *he* would have to listen to static.

"I don't know," he said in reply to Parker's last question. "Maybe the pilot ran a red light or something." He was unbolting a lunch-box-sized rectangle from beneath the control cabin's floor, one of dozens of them that he suspected were gravity generators. Thick cables connected them all to a cabinet-sized power supply that had been damaged in the attack, but Lenard hoped the floor unit might provide enough of a clue to at least understand the principle involved.

"Hah, if that's the case then we need weapons to defend ourselves against the police," said Parker.

"What makes you so sure we're ever going to encounter these guys again?" Lenard asked. "This one could be thousands of light-years from home. The odds are he jumped blind as soon as he realized he was under attack, so it's probably sheer coincidence he's here instead of halfway across the galaxy. The hyperdrive probably wouldn't dump him back

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into normal space until he was within reach of a star—or maybe even aimed straight at one—so given the average distance between stars he could be from halfway across the Universe."

Lenard took off a bolt while he waited for Parker's reply.

Parker sounded exasperated. "You have no idea how the hyperdrive works. He could be from Alpha Centauri for all we know, and the people who shot at him could be headed after him as we speak. Or he could be from halfway across the Universe and the same thing might apply. Whatever the case, we need to be able to negotiate with them from a position of strength, or we might as well kiss our whole society goodbye."

"Oh, come on," Lenard said. "I think you're being a little paranoid, aren't you?"

Lenard took off another bolt.

"I'm paid to be paranoid," Parker replied.

"Well, better you than me."

A burst of heavy static washed over the radio, but it was too early to have drowned out Parker's reply.

The third bolt was tight; Lenard had to brace himself against the power supply and shove with both hands on the wrench. As he spun it loose, he realized Parker still hadn't responded.

"Hey, are you still there?" he asked. He continued unbolting the gravity generator, but when another half a minute had gone by without a response he said, "Hello, Parker, come in."

He pulled the last bolt free and tugged the gravity generator loose, stuck it in his bag along with the other things he'd salvaged, and when Parker still hadn't answered, he pulled the bag up to the middle of the ship again and pushed it ahead of him into the cargo hold, feeling a little bit like Santa Claus going up a chimney. When he got through the hatch himself he said, "Calling Parker, this is Lenard Dennison call—"

The ship lurched against his feet. For a crazy moment he thought he had somehow lit the drive by accident, but then he saw a brilliant flash of light in the engine room and felt a slap against his leg as debris blasted through the hole.

Something had exploded. His Kevlar suit had saved him from a puncture, but it wasn't impenetrable. Lenard grabbed his bag of salvaged hardware and lunged toward the gash in the hull, hoping to get free of the ship before the whole thing went up, but as soon as he stuck his head out he gasped and yanked it back in as fast as he could.

Another alien ship floated just a few hundred meters away. This one was huge compared to the first one, and obviously not meant to land anywhere. Like Lenard's it was a lumpy, modular thing, and its entire hull bristled with appendages: parabolic dishes, rocket nozzles, and long skinny tubes that might have been anything from telescopes to gun barrels. In the brief glimpse Lenard got of it he saw the end of one of the tubes flash bright blue, and in the same instant the hull around him shuddered again. Another splash of metal fragments burst upward

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through the hatchway from the engine compartment.

The aliens were firing at him! That's why Parker's radio link had gone silent; they had probably blown up Lenard's ship already and the relay with it. He peeked out the gap again, but no, his ship was still there, apparently unharmed.

Had they shot at *Parker?* He was still a couple million kilometers away; that hardly seemed likely.

It didn't matter. Lenard was in trouble enough all by himself. As he watched, three figures popped out an airlock in the side of the alien ship and kicked off toward him.

Lenard realized what they'd done. They had fired at the engines to make sure the derelict was actually disabled, and now they were going to check it out first hand. Or tentacle. He didn't know if they were the same species as the pilot or not. They were too far away to count arms and legs, and Lenard didn't want to wait around for them to get any closer.

He wanted to jump for his own ship, but he knew he'd be seen in an instant if he did. He backed away from the gash in the hull, looking for someplace to hide, but he'd already explored the whole ship and unless he'd missed something there wasn't one. Anyone boarding the ship would be able to find him in no time, even if he crawled down in among the remains of the engines.

That left outside. Maybe he could climb out onto the hull and hide where they wouldn't expect him; or even drift free and hope they thought he was a piece of debris.

Hmm. A piece of debris that was just coincidentally drifting toward his ship.

And beaming audio and video signals of the whole trip? Stupid! Lenard reached up and switched off his helmet camera, then did the same for his radio transmitter. He left the receiver on; that wouldn't give his position away.

Was that why Parker hadn't responded? Lenard didn't know, and he could think of no way to find out.

He carried his salvage bag down into the engine compartment again. The last two shots had made a real mess of the place. The big spiny egg he'd assumed was the hyperdrive engine had been their target; not much was left of it now. The central part of the ship where it had been lay open to space, gutted like a trout, and equipment dangled out of the gap like loose intestines.

Lenard found what looked like a pump of some sort that was hanging by one unsevered wire. It was big enough to hide him if he crouched behind it. He peered out around it, trying to gauge the ship's rate of tumble now that it had taken two additional hits. He wasn't at the exact center of rotation now, so he would have to account for the extra motion when he kicked off, but he was close enough that it wouldn't be impossible, even with the mass of the pump slowing him down.

The three aliens passed by only a few meters away, headed for the first gash in the hull leading into the cargo hold. Now Lenard could see them more clearly; they had the same num-

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ber of appendages and wore the same short, barrel-chested spacesuits as the one he'd seen inside.

He tied the bag of salvaged hardware to his waist while he waited for them to climb inside the ship, then he cut the wire holding the pump from flying away and pulled himself and the pump around to the outside of the hull, keeping the pump between him and the other alien ship and the bag covering his backside. He waited for the derelict to rotate around to the right position, then kicked off at an angle he hoped would kill his tangential velocity and send him toward his own ship.

His pulse drummed in his ears while he waited for the aliens to vaporize him with their beam weapon, but when almost a minute went by and they still hadn't fired he peeked around the edge of the pump. He'd kicked a little too hard; he would miss his ship by a dozen meters or so. He took his rocket pistol out of his tool belt and fired a short burst, keeping the exhaust flame hidden behind the pump. He peeked around again, fired another burst, and put the pistol away. He would drift past near the tail now, close enough for him to leap across.

He looked behind him. A fountain of sparks was shooting away from the top of the ruined ship's hull; it looked like sparks from a torch, as if the aliens were cutting a hole in it from inside. Sure enough, a moment later an oval a couple meters across drifted free, and a few seconds after that one of the cubic cargo boxes came flying out of the hole.

The aliens' aim had been perfect. They had cut the hole so they could take advantage of the derelict ship's rotation to fling the cargo box straight toward their own. As Lenard watched, another cargo box flew out, and another with each rotation. Eventually a whole stream of them connected the two ships.

Were they pirates? he wondered. They certainly didn't care how badly they damaged the first ship. They seemed interested only in its cargo. Lenard wondered if they would leave when they got it loaded, or if they would come investigate his ship, too. They might ignore it completely, the way a sea pirate might ignore a canoe alongside a Spanish galleon, but Lenard didn't imagine he would be so lucky. They would examine his ship, take what they wanted, and then probably blow it up just for fun.

What could he do? If he fired up the drive and tried to escape they would almost certainly blast him the way they had the other ship. But he couldn't just wait for them to come get him, could he?

He wished Parker were still there. He was the military man; he would no doubt have a trick or two he could at least try. He wasn't answering, though, either because he couldn't or because he'd seen the second alien ship arrive and didn't want to draw attention to himself. Lenard supposed that was a smart move on his part, but it didn't help Lenard any.

He looked over the edge of the pump. He was almost there. He braced his feet on it and waited for the right moment, then pushed off

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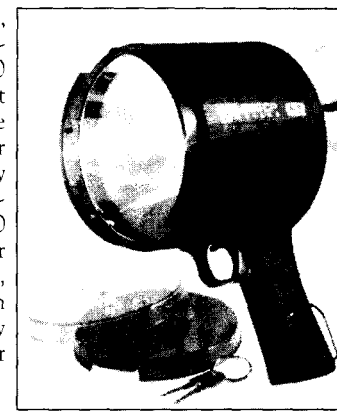

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and grabbed for the edge of his ship's high-gain antenna as he floated past. He swung around into its shadow and crawled along the side of the ship opposite the alien warship until he was near the airlock, then slowly crept around until he floated beside it. He was partially within view now, exposed to their weapons if they saw him, but he was hoping their attention was on the other ship's cargo.

The outer door slid aside into the hull when he pushed the door-open button. He pulled himself inside, tugged his bag of alien goodies in after him, and pushed the cycle button. When the outer door closed and he felt air rushing in around him, he let himself go limp. He'd made it.

But when the inner door opened he found himself looking into the open barrel of a squat, equally ugly-looking alien. He screamed, and his reflexive flinch sent him crashing headfirst into the top of the airlock.

The alien wiggled the pistol downward, then back at Lenard's chest. With exaggerated caution, Lenard reached up and pushed himself back to the same level as the alien.

"Don't shoot," he said. He untied the net bag from his waist and let it drift free in the airlock, then grasped the door frame and pulled himself into the ship.

The alien wiggled the pistol again, and he stopped. The alien leaned forward, waving Lenard back into the airlock.

"You want me to go back outside?"

Lenard didn't hear any response from it over his radio, but that hardly surprised him. He didn't even know if the aliens *used* radio, much less the same frequency and method of modulation Lenard was using. Which meant they probably couldn't hear him, either. Whether they could or not, there didn't seem to be much point in staying quiet any longer; they'd already caught him.

So before the alien could tie him up or worse, he switched on his camera and his radio transmitter again and said, "Parker, I don't know if you can hear me or not, but if you've been watching what's going on here then you know there's another alien ship looting the cargo from the first one. I managed to make it back to my own, but one of them was waiting for me. You can probably see him in the video. I think he wants me to go back outside, but I don't know what he's planning to do after that. Probably take me back to his ship."

What would they do with him over there? Lenard wondered. Would they try to communicate with him, or would they be more interested in vivisection? Considering the way they'd hacked open the cargo ship, he didn't like the odds.

Besides that, his air tank was about half empty. He would only have another couple of hours before he ran out, and then he would have to try breathing theirs. He didn't much care for that prospect, either.

And there in the back of his mind was still the nagging suspicion that Parker had gone silent for a reason, that he might be alive and planning something. "I'm paid to be paranoid," he'd said. Maybe it was time for Lenard to start thinking paranoid, too. A

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paranoid would think that Parker had planned for this all along, that he'd expected a warship to show up and had arranged something to do about it if it did. If that was the case, then Lenard would much rather not be on the alien ship when he made his move.

He needed to stall for time. Parker was only a few minutes to Sunward now; whatever he might have planned would happen soon if it happened at all.

The alien moved closer, waving its pistol again. Lenard shook his head and said, "Look, if you want me to go back outside, at least let me get a fresh air tank." He turned sideways and pointed at the life support pack on his back. "Air tank, comprendez?"

The alien seemed to get the message. At any rate, it didn't shoot when Lenard very slowly opened a storage locker in the airlock and pulled another air tank from the half dozen of them racked inside, swapped that one with the one in his backpack, and placed the half-empty one back in the rack for refilling.

"I'll need food, too," Lenard said. "Food, get it?" He pointed at his mouth, but the alien just waved the gun again.

"This isn't getting us anywhere," Lenard said. "Here." He bent over and retrieved the bag full of salvaged hardware, rotated it until the alien could see the bottom, and pointed at the stuff he'd taken out of the other ship's refrigerator. "Get it now?" he asked.

The alien seemed to. It took a while to come to a decision, but eventually it backed away and let Lenard enter his ship, being careful to stay between him and the hatchway up to the upper decks. They were in the service level, two decks down from the controls, so Lenard didn't even try to make a break for it. He floated over toward the galley, trying to get a peek out one of the four portholes spaced evenly around the circular wall, but none of them were oriented right to see anything.

A few seconds later he was glad of that. He was just reaching for the dry foods drawer when a flash of light lit up the interior of the ship like a nuclear blast. It might have *been* a nuclear blast, Lenard thought, for he felt the heat of it just in the reflection that reached him off the galley's wall.

The light faded in just a few seconds. Lenard's vision was full of afterimages, but he saw the alien back up until it could look out one of the portholes, still holding its weapon on him as it did. The alien looked outside for a second, then Lenard heard it scream. Its spacesuit helmet, and Lenard's, muffled the noise, but it was unmistakably a wail of agony.

Lenard floated over to the airlock and peered out the window in the outer door. The warship was gone. In its place, receding rapidly, was an expanding cloud of still-luminous gas.

"Parker?" Lenard whispered, then louder, "Parker, what the hell did you do to them? Parker!" He got no answer, and as he watched the gas cloud that had been the alien ship shrink in the distance, he knew. That hadn't been a simple explosion; the debris was all moving in the same direction.

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Something had blown it backward, and that something had to have been Parker. He'd used the only weapon he had: himself. Traveling at a relative ten million kilometers an hour, he had made a kamikaze dive out of the Sun straight at the aliens, and he'd hit with the force of a nuclear bomb. The only reason Lenard had survived it was because the debris had all gone the other way, slowed down in its fall toward the Sun by Parker's momentum.

"I take back all that stuff I said about paranoia," Lenard whispered. He looked over at the alien. It was watching him, its gun still upraised, but that was all bluff and they both knew it. There was only one ship capable of flight now, and Lenard was the only one who knew how to fly it. He pushed himself closer to the alien and extended a hand for the gun. After a long moment of indecision, the alien handed it over.

Lenard took it in two fingers, careful not to touch anything that might set it off. The grip was all wrong, and it had four buttons on the sides instead of a trigger. He could no more fire it than the alien could fly his ship, but fortunately he didn't need to. He tucked it in a loose pocket in his spacesuit and pointed out the window at the derelict ship. "Are your crewmates still alive over there?" he asked. He pointed at the alien, than at the other ship.

The alien didn't say anything Lenard could hear, but a few seconds later the three aliens who had been tossing cargo out into space jumped across toward them.

Lenard waited until they had all cycled through the airlock, then made them lie down on the floor and told them to stay there. That would be the safest place for them to ride out the long burn to fling them around the Sun and out again. He had no idea if they could survive one *g* of thrust, or if they could breathe his air or eat his food, but there wasn't much choice. They had one chance of survival, and this was it. Lenard would try his hardest to keep them alive until the rendezvous with the Space Authority ship on the other side of the Sun, and the Space Authority would no doubt try to keep them alive as long as they could after that, but there were no guarantees.

Nobody could know how it would turn out. They might die in a few hours, or they might live long enough for their own people to come for them, or they might have to help humanity build hyperdrive ships and take them home. The only thing Lenard could say for certain was that the next few decades were going to be some of the most interesting times in human history.

He'd heard some people say that living in interesting times was a curse, but he didn't know about that. He would reserve judgment until he'd lived through them himself.

He pulled himself upward into the control room and strapped himself into his acceleration couch. The Sun was as big as he'd ever seen it. He turned the ship ninety degrees away from it, careful to line it up precisely along the vector Parker had given him for the rendezvous, and lit the drive. Thrust shoved him back into the chair, but it felt to him as if the future was pulling him ahead twice as fast. ■

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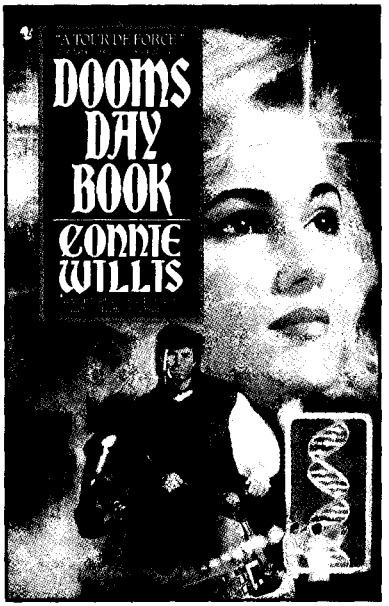

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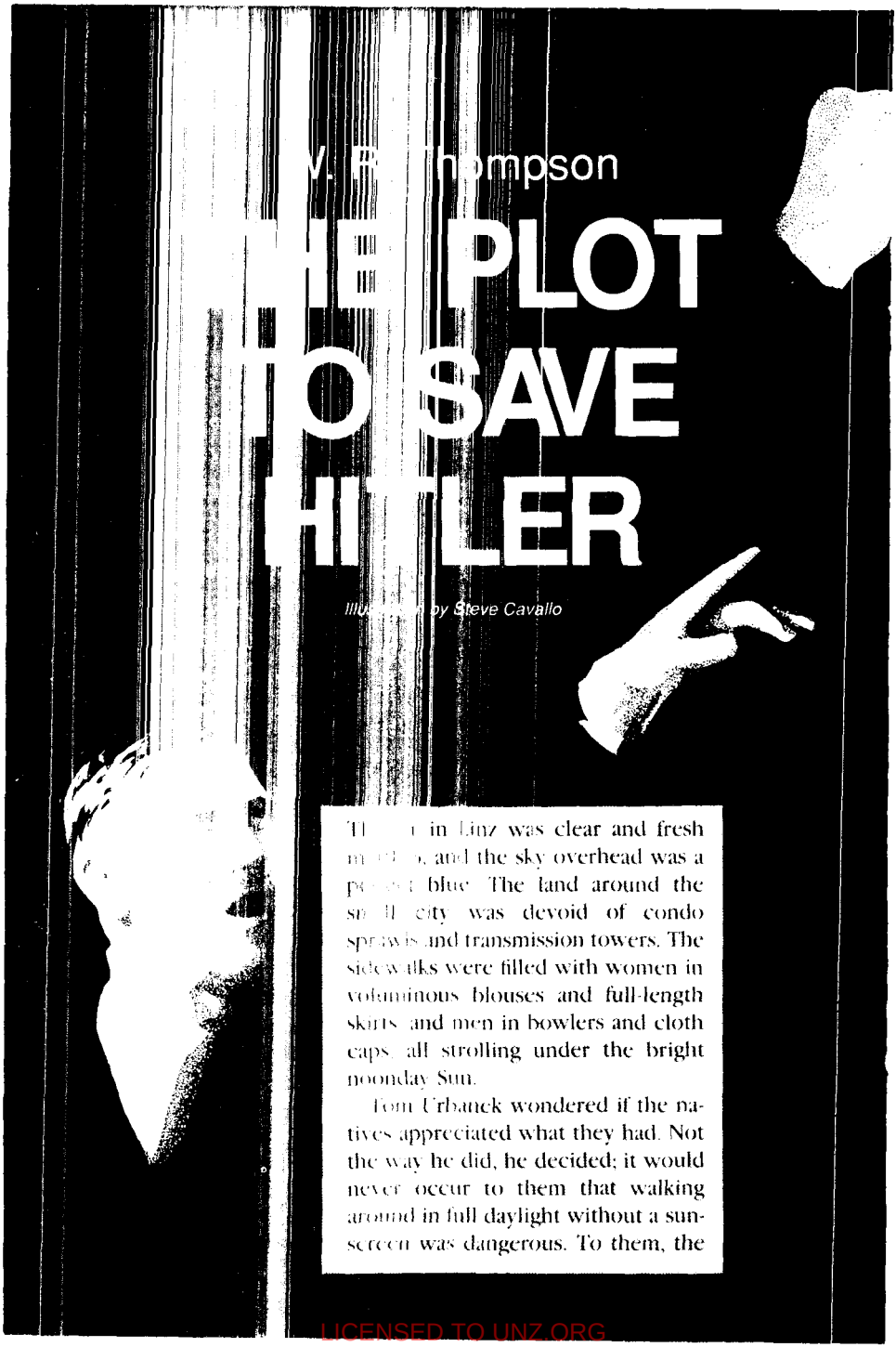

V. [illegible] hompson

HE PLOT TO SAVE HITLER

Illu[illegible] by Steve Cavallo

The air in Linz was clear and fresh [illegible], and the sky overhead was a pa[illegible] blue. The land around the small city was devoid of condo sprawls and transmission towers. The sidewalks were filled with women in voluminous blouses and full-length skirts and men in bowlers and cloth caps, all strolling under the bright noonday Sun.

Tom Urbanek wondered if the natives appreciated what they had. Not the way he did, he decided; it would never occur to them that walking around in full daylight without a sunscreen was dangerous. To them, the

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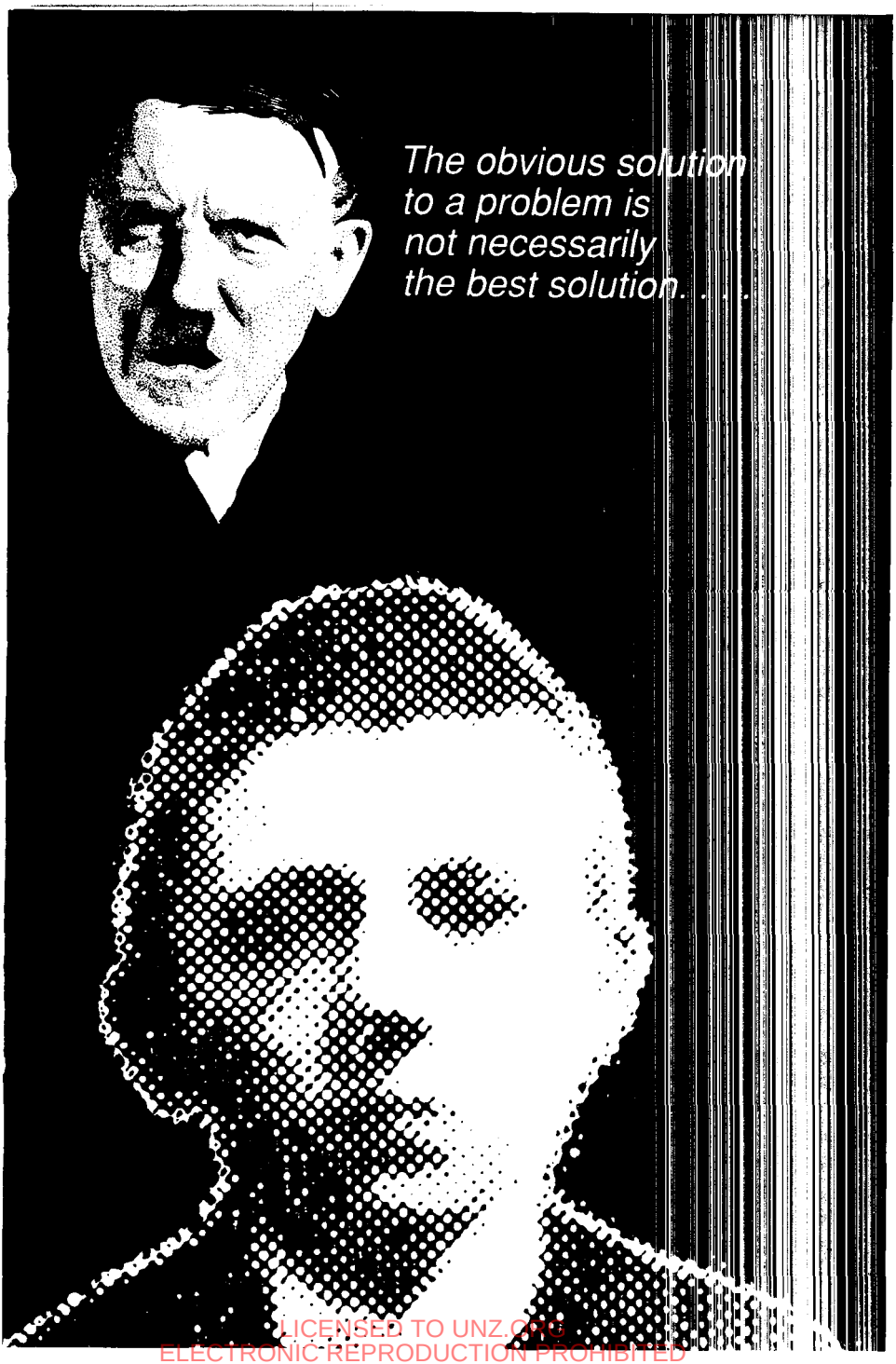

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smoke from the trains meant progress, not the makings of acid rain. Give them another century, however, and these subjects of the Dual Monarchy of Austria-Hungary would learn about pollution, ozone depletion, and skin cancer. Of course, Urbanek reminded himself, many of these people would die long before then. Their path to the future was blocked by two world wars and Adolf Hitler, the man he was here to save.

Urbanek carried his suitcase to the curb and waited for a hansom. He had materialized in the Linz railway station, where a foreign traveler was an unremarkable sight. He had stepped out of thin air into a crowd, and if anyone had chanced to see his arrival they would have assumed that Urbanek had merely jostled through the crowd; what other explanation could there be?

An open carriage with two wood-spoked wheels clattered up to the curb. Urbanek hefted his luggage into the hansom's front seat and climbed in. "Please take me to a good hotel," he told the driver, who sat on an elevated seat behind him.

"My pleasure," the man said, and snapped the horse's reins. He wore a cloth cap and spoke in Bavarian-accented German. "You are English, *ja*?"

"No, I am American." Urbanek would have preferred to avoid drawing attention by claiming he was an Austrian, but neither his accent nor his imperfect German would have permitted that.

The driver shook his head. "You have come to Linz at a bad time for an American. Perhaps you should only say that you are English."

"I've never done that yet," Urbanek said, recalling that contemporary Americans were ardent nationalists. "What makes this a bad time?"

The driver pulled the reins and the horse cantered around a street corner. "It is because there is a dangerous madman on the loose."

"A madman?" Urbanek repeated numbly. He could only mean Martin. He was too late; the Chronlab was supposed to have placed him in Linz several days before Martin attempted to change the past. One of the quantum uncertainties which made time travel possible had caused Urbanek to miss his target date.

"A *dangerous* madman!" The driver sounded cheery, as if he was glad to share an exciting bit of news. "And an American. Only yesterday he walked into the *Realschule* and tried to kill a student. 'I want to see Adolf Hitler,' he told one of the teachers. 'I am his cousin from America. I have a message for him.' And when Doctor Hümer summoned young Hitler, the American drew from his satchel one of those big revolvers which your cowboys use."

"Terrible,". Urbanek said. The Chronlab would never have allowed one of its operatives to carry a gun into the past, but they couldn't prevent a time traveler from buying one locally. "Was the boy harmed?"

"Happily, no!" The driver wheeled the hansom around another corner. "He ran out of the office while Doctor Hümer soundly thrashed the American with his walking-stick. The headmaster summoned the police, but be-

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fore they could arrive the madman had fled. The police even now are searching the woods for him. So I trust you will avoid our lovely forests, at least until they are once again safe?"

"I will," Urbanek said. The driver's words had filled him with a bleak feeling. There was no telling how much damage Martin had already done to the space-time continuum. Nobody had any experience with changing the past, and temporal physics was not a common-sense realm.

The hansom rolled to a stop in front of a hotel. It looked old and dilapidated, and Urbanek supposed that it belonged to a relative of the driver. He hoped he wouldn't be here long. That thought made him smile wryly. He didn't dare stay here long. He had to capture Martin quickly, before he could complete his work.

He paid the driver and climbed out of the hansom. As his feet touched the cobblestone pavement a young boy in a comic-opera blue uniform and a pillbox cap hurried out of the front door. "May I help you with your bag, *mein herr?*" the bellboy asked.

"Yes, please," Urbanek said. "Do you have a room?"

The boy blinked at his accent. "You are American?"

"Yes, I am." He gave the boy a silver coin.

The large tip overcame the boy's apprehension. He nodded vigorously as he took the luggage. "We still have a few empty rooms, *mein herr.*"

Urbanek followed him into the lobby. It reminded Urbanek of pictures of Edwardian-era smoking lounges, which of course it was. Light came from small windows and gas lamps. There was a counter against one wall, and pigeonholes for letters behind it. Men sat in scattered chairs, breathing the smoke of burning tobacco.

A well-dressed man stood behind the counter. The boy chattered to him in quiet excitement, and the man gave Urbanek a suspicious look. Urbanek paid for a room in advance, and threw in enough extra money to soothe the man. The man gave Urbanek a metal key, and Urbanek followed the bellboy upstairs. "Tell me something," Urbanek asked the boy. "Do you know this schoolboy who was attacked?"

"No," the bellboy said, "but my cousin Franz attends the *Realschule* with him and has told me about him."

"And what does he say?"

"That Hitler is a bully and a blowhard, always talking about how some day he will be a famous artist." They came to the top of the stairs. The door to Urbanek's room stood open, and as Urbanek followed the boy into it he found a room which looked small and uncomfortable. Light came from a window and a burning gas lamp in the wall. The mattress beneath the turned-back quilt and sheets looked lumpy.

The bellboy kept talking, obviously hoping that a friendly demeanor would lead to a larger tip. "Just last week Hitler told Franz that soon his rich grandfather would give him a big legacy, and then he would go and live in a mansion in Vienna."

Urbanek was surprised. That was

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not in any of the history books; so far as anyone knew, the young Adolf Hitler had never talked about his grandfather. "Did the boy say anything else about his grandfather?" he asked.

The bellboy shrugged. "That's all cousin Franz told me."

"I see. Thank you." Urbanek handed a large tip to the boy after he set the bag on the floor. After he skipped out of the room Urbanek closed the door. He went to the window and looked out over Linz. He could see a river in the distance, winding through the broad green valley. He supposed it was the Danube River.

Urbanek wondered if Hitler knew about the scandal attached to his ancestry. That seemed likely, if he believed he had a wealthy grandfather. Adolf's father, Alois, had been born out of wedlock, and one bit of gossip claimed his real father was Baron Rothschild, one of the wealthiest men in Europe. It sounded as though Hitler had constructed a fantasy in which the Baron would lift the boy out of his humdrum life. And—the Baron was Jewish; perhaps his anti-Semitism had taken root in the Baron's failure to fulfill his fantasy. It would be interesting to talk with Hitler and explore these speculations. That was why Urbanek had become a traveler: to unravel the mysteries that fogged history.

Damn Martin, he thought in sudden anger. The man was supposed to be in Switzerland, interviewing a patent-office clerk named Albert Einstein. Martin should have returned to the Chronlab one minute after his departure, laden with memories and microcordings. After he failed to make the recall a security agent had searched his home, and found a dozen dog-eared books on Adolf Hitler. Heavy underlinings and bookmarks showed that Martin had given his attention to the chapters on Hitler's murky boyhood. All of the books mentioned the mysterious lunatic who had tried to murder Hitler when he was fourteen years old.

Urbanek turned away from the window. Martin was dangerous as long as he remained loose, but that would help Urbanek find the man. All Urbanek had to do was to find Hitler, and wait for Martin to try to kill him again.

Urbanek went out in front of the hotel, where the bellboy hailed a hansom for him. Urbanek asked the driver to take him to Leonding, a small village three miles west of Linz where Alois Hitler had purchased his retirement home in 1899. Sensing that Urbanek was a foreigner, the driver overcharged him outrageously. Urbanek took it in stride. He was on an expense account of sorts. The Chronlab had established numbered Swiss bank accounts for its operatives; the money Urbanek spent now had been gathering interest in Zurich for almost a century.

The ride through the woods was uncomfortable; the main road from Linz to Munich was unpaved, rutted, and polluted by the horses which used it. The trip to Leonding lasted for a bone-jarring quarter-hour. The driver deposited Urbanek at the vil-

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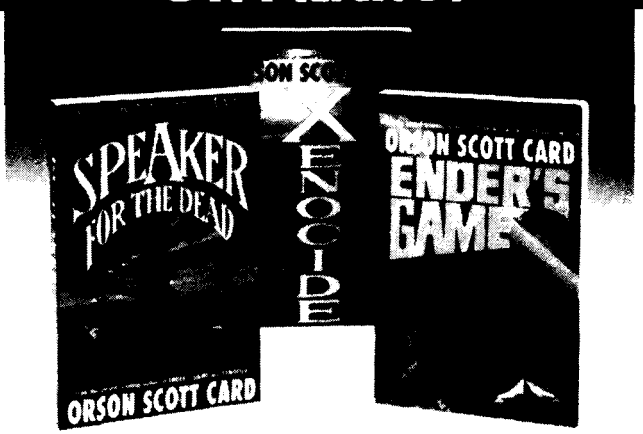

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lage's edge, then rolled into the village in search of a fare.

The village looked as though it had not changed much since the Middle Ages. The Hitler home was a small wooden structure in a crowded neighborhood, almost indistinguishable from the other buildings around it. There was no yard, no lawn, which surprised Urbanek until he reminded himself of where he was. Leonding was a small village in the Danube River valley. If children needed a place to play, the woods were only a short distance away.

Urbanek felt a momentary trepidation as he knocked on the front door. Would the budding *Führer* answer his knock? But when the door opened he found himself facing a fortyish woman dressed in black. Klara Hitler, he thought, still in mourning after the recent death of her husband, a man twenty-three years her senior. "*Frau* Hitler?" Urbanek asked.

"Who are you?" she demanded.

"My name is Thomas Urbanek," he said. "I am searching for the madman who attacked your son."

"You are not a police officer," she said in suspicion.

"No, I am a psychologist."

Hitler's mother looked blank. "A what?"

"A researcher into diseases of the mind, *Frau* Hitler." During the ride from Linz he had thought about how he would introduce himself, but it hadn't occurred to him that this ex-serving maid was not an educated woman. "I believe the madman will come here—"

Klara Hitler backed into the house and slammed the door. Urbanek heard a bolt lock into place. Three of the woman's children had died while they were very young, and all the books described her as highly protective of her surviving children. Evidently she was not about to take any chances with strange men.

Urbanek needed an excuse to stay close to the Hitler home; his only hope of capturing Martin lay in waiting for the man to come here to attack Adolf Hitler. There were no outdoor cafes within sight, however, no park benches resting under any shade trees. A loiterer was bound to attract suspicion, especially from the frightened woman locked inside the whitewashed house.

Urbanek looked down the street and saw a tall, portly man in a uniform even more ornate than that of the hotel's bellboy. He saw an obvious way to avoid suspicion. Urbanek strolled toward the man. "*Herr* Inspector?" Urbanek asked him.

The policeman smiled at Urbanek's flattering overestimate of his rank. "Only a lowly constable, I fear," he said. "Walther Strasser, at your service. How might I help you?"

"We might help one another," Urbanek said. "You have heard of the madman who attacked the Hitler child?"

Strasser gave Urbanek a complacent nod. "We expect to arrest him at any moment."

"Certainly." Urbanek wondered if police in any era ever admitted they had trouble capturing a fugitive. "It has occurred to me that he might come here, to repeat his attack."

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"Indeed?" The constable looked perplexed. "Why should he do this?"

Urbanek felt annoyed by the man's lack of imagination. "He has gone to a great deal of trouble to hunt down the boy, and I believe he will try again."

"No one can predict what a madman will do," Strasser said confidently. "Madmen act without thought or plan."

"Not always," Urbanek said. "I am a researcher into diseases of the mind, which is why this case interests me. If my theories are correct, the man will return. I believe his plan to kill this boy has become an *idée fixe* with him."

Strasser looked blank. *"Bitte?"*

"A form of monomania," Urbanek said. "He can think of nothing but killing a certain person. I would like to capture him and investigate his reasoning."

Strasser's lip curled in disdain. "You speak like that filthy Jew doctor in Vienna."

"My theories are not like those of Doctor Freud," Urbanek said. He tried not to sound impatient with the man's naked anti-Semitism. Wait a few decades, Herr Strasser, he thought sadly, and Hitler's Europe will have a place for you, if it does not consume you. "I deal in the workings of the criminal mind."

"For myself, I care nothing for the criminal's mind," Strasser said. He began walking along the street, as though suddenly remembering he had a beat to patrol. Urbanek walked alongside him. "My only thought is for the criminal himself."

"In case he returns, will you object to my assistance?" Urbanek asked.

"Not in the least," the constable said affably. "Madmen are much stronger than sane people. But if this madman has the sense to look for the boy, he will not come. The boy is not here."

"No?" Urbanek asked. "Has he been sent away?"

"No, he's gone for a walk in the woods," Strasser said. "He does this quite often, and today is no exception."

"He—" Urbanek stumbled over a cobblestone and barely kept from falling onto the village street. "With a madman on the loose? Why didn't anyone stop him?"

"I will tell you frankly, it is because he is a very strange youth and nobody has a use for him." They had come to an intersection. Strasser looked up and down the different streets before turning down one. "I spoke with him yesterday and there is something repellent about him. He is a liar and a braggart, and if he is so foolish as to go into the woods and play with his *Frauenlob*—" the constable made a coarse up-and-down gesture with his fist "—while a madman stalks him, who is to care?"

"Do you know which part of the woods he's in?" Urbanek asked.

Strasser gestured down the narrow village street. "This road ends at the base of the hill, where there is a hunter's trail into the valley. Several times I have seen the boy upon that trail."

Urbanek hurried off without another word. He was out of breath by

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the time he reached the end of the road, and he was gasping as he started up the narrow dirt trail. Out of shape, he thought. Unprepared, physically as well as mentally. He'd never had the chance to learn that young Hitler liked to stroll in the woods. Martin had been plotting his activities for months, perhaps years. He must have known everything there was to know about the Adolf Hitler of 1903—facts, innuendoes, speculations, everything. Urbanek had barely had the time to skim Martin's books before he was dispatched into the past by scientists who feared the unknowable consequences of delay.

The trail along the northern slope of the hillside wound through a pine forest before it turned into a steep-sided box canyon. Urbanek paused and checked his armament: a fountain pen which sprayed tear gas. It wouldn't be much use against Martin's pistol, but it was better than nothing. Urbanek started walking again, pushing himself up the sloping trail.

"OK, freeze," a voice said in English.

Urbanek stopped walking. "Martin."

"Urbanek." The man came out of the trees behind Urbanek. His face and hands were bruised from the caning Hümer had given him. He held an antique Colt revolver in one hand, and with the other hand he patted down Urbanek. He cleaned out the man's pockets and tossed everything he carried into the woods. "Now I'm sure you're unarmed," he said, "but I'm going to play it safe. Over there." He gestured with the pistol.

Urbanek stepped off the trail ahead of Martin. "You haven't found Hitler yet."

"I found him." Martin sounded chagrined. "But I missed the little son of a bitch. Fifty feet away, standing on top of a boulder like it was the podium at the Reichstag, and I still missed him. I swear, it's like the forces of history were protecting him."

"Did you try to shoot him in the back?" Urbanek asked, his voice acid.

"Adolf Hitler? Of course. Sit down." The two men squatted on the ground. The slope was steep and Urbanek braced his back against a tree trunk. Martin kept the pistol aimed at Urbanek. He sat where he could watch both Urbanek and the trail. "Are you going to say I shouldn't kill him because he's fourteen now?"

Urbanek didn't think arguing with the man would do much good. He decided to keep Martin talking; if he could distract the man he might surprise him. "I was just wondering how it feels to gun down a kid."

"I wish I'd hit him so I could tell you." Martin spoke quietly. "Know what he was doing when I spotted him? He was making a speech to a stand of pine trees, practicing his oratory. It would have been funny if I hadn't known it was *him*, warming up for his career as a demagogue. He already has the dictator bug."

"So that's how you knew he'd be out here," Urbanek mused. Historians had regarded that as an unsubstantiated rumor about Hitler's youthful behavior. "You really did your

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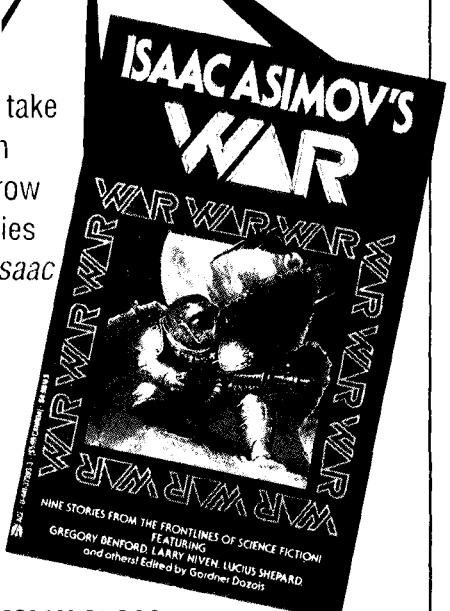
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homework."

"Keep your voice down," Martin said. "I don't want to scare him off."

"Do you think he'll come anywhere near you?" Urbanek asked.

"Unless he's part mountain goat, he'll have to," Martin said. "That trail is the only way out of this valley."

"He'll wait. He's not an idiot."

Martin snorted in derision. "You're a Czech, aren't you?"

"No, but my grandfather was born in Plzen. What of it?"

"Doesn't a Czech feel strange trying to save Hitler's life?"

Urbanek shrugged. His grandfather had fled Czechoslovakia in 1939, when Hitler had occupied the country, but Urbanek could feel no emotional involvement with that. "I'm trying to save our era. If you kill Hitler, you'll change the course of history."

Martin rolled his eyes, but not enough for Urbanek to risk jumping on him. "That's the idea."

"Well, it backfired," Urbanek said. "The history books say that an anonymous nut tried to kill Hitler when he was fourteen. What you've done is the key to his whole career—he's going to convince himself that you're an agent of some international Jewish conspiracy, sent here to thwart him—what's so funny?"

Martin was smiling. "The history books didn't say that when I left. Give me another crack at him and I'll make a *real* change."

"So you're going to keep playing God?" Urbanek asked.

"God?" Martin spat angrily. "Where was God when Hitler was in power? Doing nothing, just like you. *You* go and play God; I want to save some lives."

"By taking a life?" Urbanek asked.

"Hitler's life. He—"

Without any warning Martin bolted to his feet and charged up the trail. For a moment Urbanek was too startled to move. As he stood he realized that Martin had distracted *him* with their talk. Now Martin was twenty feet down the trail, and as Urbanek ran up behind him he got a glimpse of a round-faced, black-haired boy dodging into the woods.

Martin started shooting. He fired from the hip, and he got off three rounds before Urbanek tackled him. The two men fell and skidded downhill, off the trail, sliding on a bed of dry leaves until they banged against a tree trunk. Martin dropped the pistol then, and before the man could react Urbanek grabbed it, pushed himself away from Martin, and aimed the gun at him.

Martin sat up, shook his head hard and looked at Urbanek. "Go ahead, kill me."

"I'm not a killer," Urbanek said. The pistol felt massive in his hand, and he remembered what he'd seen as Martin fired. "Forces of history, *hell*. You missed because you're a lousy shot."

Martin swore. "So now what happens?"

"We—" Urbanek patted his vest pocket; the recall unit was disguised as a gold watch. Martin had tossed it aside when he had emptied Urbanek's pockets. "We pick up my belongings and go home," he said. "And then you're off the project."

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Martin looked startled. "That's all?"

Urbanek nodded. "You haven't broken any laws. There's attempted murder, but this is outside American jurisdiction. The Chronlab regulations against meddling aren't laws, so—"

"Christ!" Martin laughed. "No wonder they sent you. Anybody else might have changed his mind about stopping me. All you can do is think like a lawyer."

"You're probably right," Urbanek agreed. He motioned with the gun, and went to the spot where Martin had tossed his belongings. All he needed was the watch, but he wanted to pick up everything else. The teargas pen, his bank book—it was better not to risk any anachronisms. Everything lay scattered in the leaves, and he had to divide his attention between Martin and the search while he groped for the odds and ends.

Martin did nothing to help. "Do you know how many people Hitler killed?" he asked, as he sat down under a tree.

"About forty-five million," Urbanek said. He found the bank book and pocketed it. "Twenty-eight million when he invaded the Soviet Union, six million Jews in the camps, plus five million Slavs, Gypsies and others in more camps, and a few million other people around Europe. Does it sound like you changed anything?"

"No, that's how the record stood before I left," Martin said. "Hitler committed suicide in his bunker in Berlin on April thirtieth, 1945. Eva Braun died with him."

"That hasn't changed, either," Urbanek said. He found the pen and his wallet while he dredged up the few things he knew about World War Two. "Buzz bombs and rockets."

"Hitler used V-1s and V-2s before I left. What about the war's aftermath? Russia was backward when Hitler invaded. It had to turn into a military power to defeat Hitler. Did the Soviets still come out of the war as a superpower?"

"Yes," Urbanek said impatiently. "I think we've established that you didn't accomplish anything here."

"Neither did you." He began stirring the leaves at his side with his fingers. "The last half of the twentieth century is still a mess, and you can trace almost all of it back to Hitler. You—"

"Shut up," Urbanek said.

"Why? You getting uneasy?"

"You're trying to distract me again."

Martin sighed. "I didn't think you'd fall for that twice. Just tell me why you're so determined to keep Hitler alive."

"I'm not. Get your hand out of the leaves." He didn't want Martin to throw a handful of dirt into his face. That seemed like the sort of trick a desperate man would try.

"Just tell me," Martin persisted. "All those millions of dead aren't real to you, are they? They're just historical ghosts. You don't care what happens to them."

Urbanek found the watch. "Get up," he said.

Martin stood up. Urbanek kept him covered while he opened the watch casing, one-handed. The watch face

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flipped away, revealing the control buttons. Urbanek started to press in the recall sequence with his thumb. That was a bit clumsy, and he had to watch what he was doing.

Martin had been waiting for that. He scrambled away from Urbanek, and before Urbanek could think to shoot at him the man was lost among the trees.

Urbanek clamped down on his temper; he couldn't afford to let anger cloud his mind. At least he had taken the gun away from Martin. That had to count for something, although a bad shot like Martin was probably more dangerous without the gun.

It was getting dark, and Urbanek knew he could not hope to hunt down Martin at night. He walked back into Leonding, where he found Strasser still walking his beat. "You look a sight!" the imperturbable policeman said.

"I know," Urbanek said. He brushed at some of the dust he'd picked up while fighting Martin, then held out the pistol, butt-first. "I found the madman. I took this away from him."

Strasser accepted the pistol and tucked it into his belt. "But the madman himself escaped you?"

"You were right about his strength," Urbanek said as he straightened his coat. "Have you seen the Hitler boy?"

Strasser nodded, and waved a hand down the narrow village street. "I saw him go running home to his mama not long ago. Was there trouble?"

"The madman shot at him," Urbanek said. "Where are the men you said were looking for him? I didn't see them."

"Oh, they came home some time ago," Strasser said, as placid as ever. "And did you get to interview your pet madman?"

"I managed to speak with him," Urbanek said. He thought he saw a way to kick Strasser out of his complacency. "He has a strange monomania. He picks a victim, then hunts that person like an animal until he kills him. Then he starts over with a new victim."

"How strange," Strasser mused. The idea of a serial killer was new to him, but he did not dismiss it out of hand. "Then after he kills the Hitler boy he will try to kill another person?"

"And another, and another," Urbanek said. "But if we use the boy as bait in a trap, we can capture him and stop him."

"*Ach*, well, we are already watching the boy—"

"No, he must be watched constantly, both night and day," Urbanek said. "The madman's insanity is balanced by cunning and determination. We cannot tell when he will strike again."

The policeman seemed disgruntled by the thought of a round-the-clock vigil, and he argued against it while he led Urbanek to the village police station. His superior, a plump man in a uniform as ornate as Strasser's garb, sat on a stool behind a high booking desk and listened indifferently to Strasser and Urbanek as they argued the situation. Urbanek began to understand why these two had been

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posted to duty in an obscure village; even the dullards who ran the Austro-Hungarian empire could have seen that they were unfit for anything more demanding.

At last Chief Karlburg nodded. "We must do something about this madman," he said. "People are beginning to talk, and that is not good. Strasser, you can spend the night at the Hitler house."

"Jawohl," Strasser said glumly.

"I will gladly volunteer to help," Urbanek said.

Strasser brightened. "Perhaps he can take my place this night," he suggested.

"No, but the *herr Doktor* can accompany you," Karlburg said. He picked up a letter and adjusted his monocle, ostentatiously dismissing them.

The Sun was setting when Urbanek and Strasser arrived at the Hitler house. Klara Hitler appeared relieved to see the policeman, and her earlier mistrust of Urbanek evaporated when Strasser explained that he was a famous American doctor, and had already battled the madman once today. She was quite agreeable to having the two men guard her home, and she invited them to join her family at dinner.

The Hitler children sat down at the table when their mother brought out dinner. Urbanek listened with only half an ear as Klara introduced them; he already knew something of them from his studies. Paula was seven years old now; the girl seemed half-witted at best, and might have been a borderline schizophrenic. Angela, Alois's daughter by an earlier marriage, was nineteen or twenty; she was large, strong-looking and cheerful. Adolf had turned fourteen last month and was the apple of his mother's eye, but he regarded Urbanek with unmistakable hostility. Klara did not mention Alois Junior, who had left home several years ago and was currently in jail for theft.

The family said grace. Urbanek, who had forgotten the Hitlers were Catholic, crossed himself and joined the mealtime prayer. The meal was good, and while he ate Klara asked him about the United States. Urbanek answered as best he could, although he was hampered by his limited knowledge of contemporary America. Teddy Roosevelt was the president; he remembered just in time that the Wright brothers hadn't made their first flight until the end of the year. Angela wanted to know how many cowboys and Indians Urbanek knew; like many Europeans her vision of the country was dominated by the Wild West.

"I know about those big guns your cowboys use," Adolf said suddenly, looking up from his sausage. He had remained silent until now. "They are not so much."

"Adolf, please," Klara said, "let us not talk about guns."

"They are not so much," the boy repeated. "When that man shot at me, I stood my ground and faced him down, and he could not hurt me." He stared at Urbanek as though daring the man to call him a liar.

Strasser laughed at him. "I saw you run home, little boy, so do not tell

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me how brave you were."

"You cannot call me a liar!" Adolf shouted, his voice cracking. "It was I alone who faced the madman! *You* cannot deny what you saw!" he added, looking to Urbanek. He understood the reason for the boy's hostility now. Adolf was afraid Urbanek would expose his lie.

Urbanek saw how Klara shook with fright, and he thought the woman might throw the two men out if they offended her favorite child. "Your mother is right," he said. "Let us not talk about guns." Adolf lapsed into a sullen quiet while Urbanek described a Wild West show to Angela. He was only repeating what he remembered from an old movie, but it impressed her.

After dinner Urbanek and Strasser sat in the front room and discussed politics while Klara and her two daughters cleaned up in the kitchen. Adolf had gone to his room, under orders from his mother to do his homework. Urbanek hoped the boy's studies were as dull as Strasser's opinions on how the Hapsburgs should run their empire.

Bedtime came as a welcome relief from the talk. "There are only two ways to enter the house," Strasser told Klara. "The front door and the back door. *Herr Doktor* Urbanek will watch the front while I watch the back, and between us we will stop any trouble."

"Our man might enter through a window," Urbanek said.

"Nonsense; he is not a burglar and has no experience with such things. The shutters and the glass will stop him, unless he wishes to risk an injury. You may sleep soundly tonight, *Frau* Hitler."

Klara Hitler disappeared into her bedroom. Strasser took a chair from the dining room and carried it to the back door. He propped it against the door, sat down and closed his eyes. Urbanek had to admit that the arrangement made a certain amount of sense; Martin would wake the man if he tried to open the rear door. Urbanek planned to stay awake, however, on the theory that Martin was too clever to simply walk in through the door.

Urbanek went to the front room and sat down. The only light came from a turned-down gas lamp, and the feeble light put him in a brooding mood. Sitting down to dinner with the future dictator had been a disorienting experience. It was almost impossible to reconcile this—this *punk*, he thought, with the charismatic monster who had created the Third Reich.

He wondered if Martin didn't have the right idea. Kill this boy and there would be no Auschwitz, no Guernica, no Operation Barbarossa. The United States would not start the Manhattan Project to counter the threat of a Nazi A-bomb; there would be no thousand-plane raids to make the wholesale slaughter of civilians an acceptable strategic practice. What was so sacred about that particular stream of events?

Well, he thought, he wouldn't have been born if his grandfather hadn't fled the Nazis in 1939; Milan Urbanek had had no other reason to go to

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America. The Chronlab might not come into existence, either, and that might create a paradox. The real danger was that a change in history would disrupt reality itself. The Chronlab scientists spent much of their energy arguing about such possibilities.

But Martin had already changed history, inserting an attempt on Hitler's life, and the Universe hadn't ended. It wasn't a great change in the course of events, but it *was* a change. Seen as a matter of quantum physics, it didn't matter if humans thought the change was insignificant or world-shaking. Urbanek wondered if he should just stand aside and let Martin kill Hitler. That would be easy, and it was not much different from saving Hitler merely to preserve history.

He sighed and settled back in his chair. If only Martin had stayed in Switzerland and interviewed Einstein . . . then he would not have to face these questions. . . .

A shattering crash and a high-pitched scream jolted Urbanek awake. He had just enough time to realize he'd dozed off when he smelled smoke and heard a high-pitched scream somewhere in the house. Another scream almost drowned out a second sound of breaking glass. Deprived of his gun, Martin had turned to arson, using the Molotov cocktail almost forty years before Finnish soldiers invented it.

Urbanek began coughing as the house filled with smoke. Strasser ran out the back door in panic, and either Klara or Angela dashed out the front. Urbanek heard more screams. All of the rooms were ablaze, and one bedroom was filled with sheets of fire. Shielding his face from the heat with his arms, he went into the bedroom, grabbed the child and ran blindly into the hallway. Outside, coughing from the smoke, Klara grabbed the child from Urbanek and screamed that Paula was still inside. Over the roar of the fire, Urbanek heard more screams from inside the house.

The house was burning fiercely despite the efforts of an impromptu bucket brigade. The flames brightened as part of the roof collapsed, suddenly ending the screams. The flaring orange glare showed Urbanek that he had just saved Adolf Hitler from burning to death. He hadn't even stopped to wonder who he was saving.

Strasser was officiously directing the neighbors, who had come into the smoke-filled night sky to watch the show. When two men in flannel nightclothes dragged Martin toward him, Strasser produced manacles and clamped them on his wrists.

Martin pulled free when he saw Adolf Hitler. "You maniac!" he shouted in English at Urbanek. "You saved *him!*"

Urbanek said nothing before Strasser dragged Martin off to jail. He realized that the man had been wrong about one thing. He didn't think of these people as figures from the dead past. He was more concerned with them than Martin, who had just killed a seven-year-old-girl.

That was the moment when he knew he had to change history.

* * *

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Klara and Angela were both in deep mourning after Paula's funeral, but despite his new black suit and black arm band Adolf seemed almost exalted. Both *Mein Kampf* and Langer's *The Mind of Adolf Hitler* told Urbanek precisely what the boy was thinking. A madman had tried to kill him because he was a tool of destiny. Why else would anyone want to take the life of a seemingly unimportant schoolboy? It was time to drive a stake through the heart of young Adolf's fantasies.

The best restaurant in Linz did not impress Urbanek, but it had a private room where he could speak with the surviving Hitlers. "It is time for me to come clean, as we say in America," he began. "I am a detective, not a psychologist. I told that story because Alois's father told me to spare your family any possible embarrassment."

"My grandfather?" Adolf asked, his blue eyes alert. "Is he truly a baron?"

Urbanek shook his head. So Hitler really did believe the gossip. He'd been counting on that. "No, he was a wealthy American, and he came from a Christian family. He traveled across Europe when he was young, but his behavior was, let us say, not Christian.

"He is over ninety now, and he regrets his sins. When he learned that a serving-maid in Strones had borne him a son, he decided that he would see to it that the boy and his family would want for nothing. He placed a large amount of money in a bank in Switzerland—"

"—and told you to give it to me?" Adolf asked greedily.

"He sent another man first," Urbanek said, ignoring him. "But he made a mistake. Martin, the man he sent, got greedy and decided to keep the money for himself. Before he could do that, he had to kill all of the people for whom the money was intended. When your benefactor learned this he sent me to stop the man. You already know I wasn't fast enough, but the money is yours now." He held out the bank book to Klara.

Adolf looked crushed. He clearly didn't want to believe that his attacker had anything as sordid as greed for a motive. "We don't want your filthy money!" he screamed.

"Oh, Adolf, be quiet," Klara said. She opened the bank book, and it almost slipped from her black gloves as she stared at the balance. "This—this—"

"It's over one million Swiss francs," Urbanek said.

Klara looked dazed. "I don't even know what we could do with so much money."

"I would suggest that all three of you take a long trip around the world," Urbanek said. "It will let you put things behind you. Then—well, you will have a fine dowry for Angela, and you could send Adolf to the best art schools in the world, and set him up for the rest of his life in a good artist's studio."

"We don't want your filthy money," Adolf repeated, but without any conviction. He looked hollow, as though he had just been robbed of his dearest dream. In a way, Urbanek thought, that was exactly what had happened; Urbanek had just ended

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Hitler's fantasy of being the grandson of a wealthy nobleman. And if Hitler's anti-Semitism sprang from Baron Rothschild's failure to fulfill his self-important fantasies, as he had speculated, then Hitler had just been deprived of his main reason for hating the Jews.

The boy looked crushed by Urbanek's revelations, but Adolf soon rallied and by the end of dinner he would do nothing but talk about the great studio he planned to open in Vienna. After dinner Urbanek escorted the family back to their hotel, then took a clattering horsedrawn cab to the Leonding jail. In the jarring ride over the rough road his speculations seemed as shaky as Adolf's fantasies, and he wished he could know that he had made the right decisions here.

Strasser and Chief Karlburg were both happy to see him, and nothing was too good for the man who had helped them apprehend a dangerous killer. They didn't mind if the *herr Doktor* spoke in private with Martin; they were too busy discussing how soon they would be promoted for their exploits in capturing the lunatic.

Martin sat on a cot in a brick-walled cell. "Well done," he said acidly. "You saved Hitler, and you convinced everyone I'm nuts. History is safe. Do we go home now, or do you leave me here?"

Urbanek shook his head. Martin had tried to kill him a little while ago, but to his surprise Urbanek felt no anger, no hatred. "I need to know what happens next with Hitler," he said. He had to know if there were any warning signs he should watch for in the coming years.

"He moves to Vienna in a few years," Martin said. "He tries to become an artist. He sells a few paintings, but he won't make a living at it. He lives in flophouses, dodges the draft, and makes friends with some radical anti-Semites. That's where he got interested in politics."

"Maybe he won't," Urbanek said.

Martin peered at him through the gritty bars. "Won't what?"

"I gave Klara Hitler my bank book," Urbanek said. "Adolf's a millionaire now. He can spend the rest of his life playing artist—"

"You—" Martin lunged at him. Urbanek backed away as the man slammed against the bars. "You *idiot!* That won't change anything! He'll just give it to the Nazis when he joins them."

"If he joins them," Urbanek said. "Maybe he'll be too busy playing artist to get into politics. And I think I nipped his anti-Semitism in the bud."

"If, maybe, you think—" His rage spent, Martin sat on the cot's edge and ground his fists against his temples. "The only way to stop him is to kill him. You *know* that."

"No, I don't." He held out his watch. "Here."

Martin looked up. "What are you doing?" he asked in suspicion.

"If I send you home, you won't be a threat to Hitler," Urbanek said. "As for me, I think I've made enough of a difference to keep Hitler from creating the Third Reich, but if I'm wrong—a man shouldn't run away

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from his mistakes."

"So you're going to stick around?" Martin glowered at him as Urbanek nodded. "If you're wrong, that's going to be a big comfort to the dead."

"I know." He watched as Martin got up, reached through the bars and took the watch. "Wait a few hours. I don't want them to think I helped you escape."

"I will." Martin pocketed the watch. He eyed Urbanek as if no longer sure who was the prisoner. "What is so damned important about saving *him?*" he demanded.

Urbanek sighed. "It's *not* killing him that counts. Martin, some things have got to be *wrong.* Killing him now, when there's another way to stop him—"

"That's crap and you know it. This is no time for morality!"

"Then what makes you any different from Hitler?" Urbanek asked in disgust. "Aside from the fact that you've already killed somebody?"

"That was an accident." Urbanek heard no remorse in his voice. "Besides, stopping Hitler is worth it."

"You mean, everything's relative?"

"In this case, yes."

Urbanek turned his back on Martin. He called Strasser, who opened the cell block door, and while Urbanek walked out of the block the constable asked Martin if he wanted dinner. Meanwhile Karlburg crooked a finger at Urbanek, and asked him if he had learned anything from the madman. Urbanek was about to say he was baffled by the case when Strasser burst into the room, his face pale. "Sir, I was looking right at him—" His mouth clicked shut as he saw Urbanek.

Karlburg rushed into the cell block, followed by Urbanek. Martin had vanished, and Urbanek was not surprised that he had broken his promise to wait.

For a while Urbanek thought he was going to be accused of aiding in an escape. Both policemen suspected Urbanek of helping the prisoner to escape, but they could not think of a plausible way to put the blame on him. They finally decided to leave the matter until morning, and when Karlburg remarked on the age and worn condition of the cell door's lock Urbanek suspected that they would "discover" the escape then.

It was close to midnight when they allowed Urbanek to leave. There were no cabs on the streets, and Urbanek walked back to Linz on the starlit country road. Not everything was relative, he thought. Martin would have learned that if he had interviewed Einstein as he was supposed to have done. The speed of light in a vacuum was an absolute, as were acceleration, charge, and Planck's constant. Physics could not work without certain constants, and perhaps morality was the same way. There was murder, and there was standing aside when something could be done.

Uncertainty seemed the only absolute as Urbanek walked along the dark road. If he had made the right decision, or the wrong one, he would find out the same way everyone else did: one day at a time, traveling into the future at a rate of one minute every sixty seconds. ■

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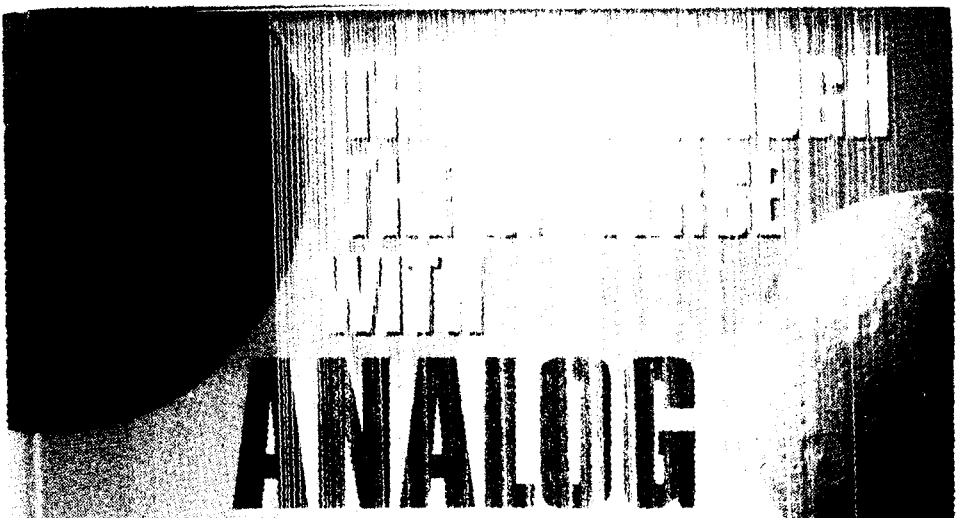

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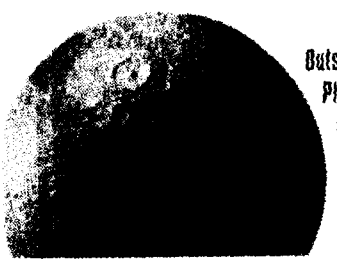

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Robert M. Zubrin

THE HYPERSONIC SKYHOOK

Introduction

Skyhooks. Many readers of science fiction and speculative astronautics have heard of such devices, and why they can't possibly work. I think they can—but let's begin at the beginning.

Way back, in 1960, the Soviet newspaper *Komsomolskaya Pravda* published an interview with engineer Y. N. Artsutanov,[1] containing a description of a novel means for Earth to Orbit transportation. In the Artsutanov scheme, a satellite placed in geostationary orbit would simultaneously extend cables down towards the Earth and in the opposite direction, keeping its center of mass, and thus its orbit, constant. This procedure would continue until the lower cable reached the surface of the Earth, where it could be anchored, and used to support elevator cabs. These cabs, in turn, could then be used to transport payloads up to the satellite where they could be released into geostationary orbit. Alternatively, if allowed to proceed out along the outward cable, the payloads could be released with greater than orbital velocity, so that at different stations along the outward cable, payloads could be released to proceed on trans-Lunar, trans-Mars, trans-Jupiter and other trajectories of interest. This concept, while published in both Russian and English, was widely ignored and promptly forgotten, only to be re-derived, and published by a group of American oceanographers[2] in 1966, after which it was forgotten again. The concept was then independently discovered for a third time in 1975, by Jerome Pearson[3], of the Wright Patterson Air Force Base, who published a series of papers going into much greater detail than the earlier authors, including derivations for system mass, tether taper configuration, and allowable limits to the rates that payload could be moved along the tether without exciting dangerous vibrational modes. Subsequently,

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the geostationary skyhook concept was widely publicized by Arthur Clarke, who employed such a device as a central feature of his novel *The Fountains of Paradise*.

While offering the exciting prospect of a simple cable car-to-orbit system, the geostationary skyhook described by Pearson and the others suffered from one little flaw: it was impossible. The reason why it was impossible was this: if one places a load at the bottom of the geostationary tether, the bit of tether holding it must be thick enough to support that load. The next bit of tether must then be thick enough to support, not only the load, but the load plus the bit of tether supporting it. Thus, as it proceeds from the ground towards geostationary altitude, the tether must get thicker and thicker, and its diameter expands exponentially. Depending on the strength-to-weight ratio for the tether assumed, the final result would be that the cross sectional area of the tether at the satellite would be 6 to 20 *orders of magnitude* greater than its area at its base, with similar fantastic ratios holding between the tether system mass and the mass of the payload it is required to lift. In answer to this problem, Pearson could only propose that in the future, ultra-strong materials, such as single crystal graphite fibers, might become available with orders of magnitude improvement in strength-to weight over current materials, resulting in exponential reductions in taper diameter ratio and system mass. Until such futuristic materials became available, skyhook applications would have to be limited to lower gravity bodies, such as the Earth's Moon, where while the problems faced by skyhook engineering are greatly reduced, the imperative for an alternative to rocket transportation is correspondingly less compelling.

A potential means of bringing the skyhook back down to Earth was offered in 1977, by Hans Moravec[4], who proposed that the skyhook be placed in an orbit lower than geostationary, and the two tethers extending from it be made to rotate, or "roll" so that during its descent through the atmosphere, the tether tip would be moving backwards at an equal speed to the skyhook's orbital velocity. This would cause the tether tip to briefly possess a ground track velocity of zero, at low altitude, thus enabling a payload on the ground or on a slow flying aircraft to be transferred to the tether for a ride into space. By bringing the skyhook to a lower orbit, the length of the skyhook is reduced, creating the potential for a large reduction in system mass. This idea was subsequently elaborated and improved upon by Rod Hyde[5] and Pearson[6]. The realization of the mass reduction potential in the rolling skyhook concept is restricted however, by the fact that as the two tethers spin about the system center of mass, centrifugal force is generated which is additive to gravity while a tether is in the downward position, and negative to it when the tether is in the upward position. This adds both static and dynamic loads to the tether system, requiring tether thickening and mass increases. The result is that

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futuristic materials are still required for the construction of a practical system. As an operational system, the rotating tether suffers in comparison to the geostationary tether by the brevity of potential access, and by the fact that while a payload can reach a stable orbit condition by climbing the tether to the skyhook center prior to release, and injection energies for interplanetary velocities are easily attained during release from the tether during its upward, forward moving swing, useful injection orbits may be difficult to attain due to the lack of correspondence between the tether's motion and the proper orbital phasing for payload release (i.e. the tether will generally not be moving through its upward arc at the right moment to throw the payload where it is supposed to go.)

In this article I present a third type of tether-skyhook system, which I call a hypersonic skyhook (Fig. 1). As I shall show, the hypersonic skyhook has the potential of relieving the severe strength-of-materials demands which have thus far prevented the implementation of a practical skyhook of either the geostationary or rotating varieties. The hypersonic

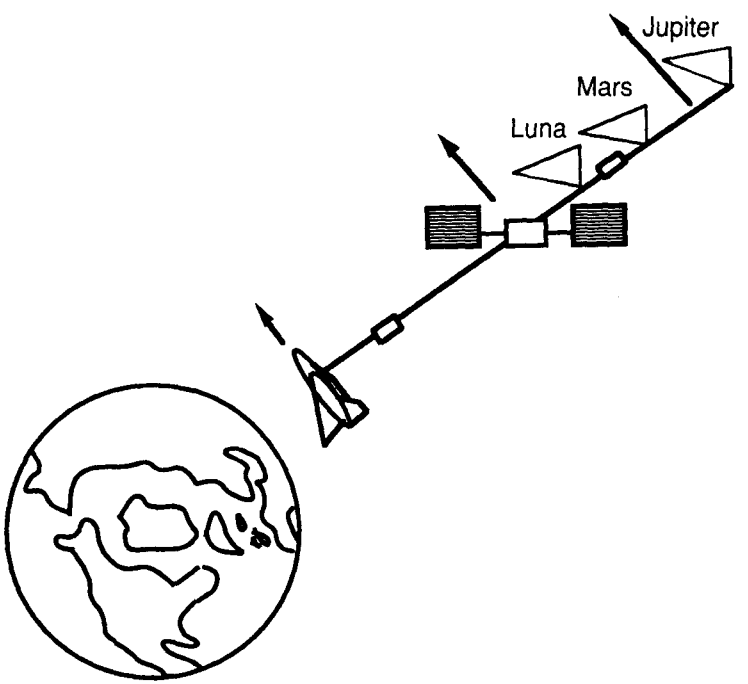

Figure 1: The Hypersonic Skyhook

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skyhook accomplishes this by keeping the tip of the extended tether outside of the tangible atmosphere and allowing it to move at hypersonic velocities with respect to the ground. This allows the skyhook's center of mass to be lowered from geostationary altitude, reducing the length of the tether, and cutting its mass and taper ratio by many orders of magnitude. Unlike the rotating skyhook, however, the hypersonic skyhook does not spin about its satellite center of mass, but keeps both tethers aligned along a constant radial direction towards and away from the center of the Earth. This causes the centrifugal force term along the tether to be constant in time and always antigravitational in nature. This eliminates the dynamic stresses faced by the rotating tether and causes a further exponential reduction in tether mass, as the gravity term driving the tether mass expansion is negated more and more when the tether's orbital velocity increases. The result is that tether systems with masses only one or two orders of magnitude greater than the payloads to be lifted become possible using present day or near-term materials, for hypersonic tethers moving with ground track velocities in the Mach 10-15 range. Because the atmospheric drag caused by traveling through the atmosphere at such velocities is unacceptable, the base of the hypersonic skyhook must travel outside the atmosphere, perhaps at an altitude of about 100 km. Access to the hypersonic skyhook would have to be provided by transatmospheric vehicles capable of matching horizontal velocity with the tether and utilizing vertical rocket thrust to negate gravity during rendezvous. While the design of such vehicles is certainly a significant challenge, it is much less formidable than the development of transatmospheric vehicles with full orbital (Mach 25) capability. The hypersonic skyhook, moreover, allows the payload to be sent from suborbital trajectories, not only to orbit, but to any destination in the Solar System without the further use of propellant.

The Skyhook Equations

The relevant equations governing the performance of a hypersonic skyhook can be derived as follows: (If you have trouble with equations, don't worry about it. Just skip ahead to the bottom-line results which are given in the following section.)

The amount of mass in a given segment of the tether is given by:

$$dm = \rho a \, dl \qquad (1)$$

where ρ is the density and a is the cross-sectional area.

The amount of additional load added to the tether due to this segment is given by:

$$dF = g \, dm - \omega^2 (R_1 + l) \, dm \qquad (2)$$

where g is the gravitational acceleration at the altitude of a given tether location, R_1 is the distance of the base of the tether from the center of the Earth, l is the distance along the tether from the base, and ω is angular velocity (in radians per second) of the tether with respect to the center of a fixed (non-rotating) Earth.

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The local gravitational acceleration, g, is given by:

$$g = g_1 \frac{R_1^2}{(R_1 + L)^2} \qquad (3)$$

where g_1 is the gravitational constant at the base of the tether.

Putting equations (1), (2), and (3) together and noting that the force, F, at any point along the tether equals σa, where σ is the tether material yield stress, we can obtain an equation for how the tether cross sectional area, a, changes with respect to its length, L.

$$\sigma \frac{\partial a}{\partial L} = \rho a \left(g_1 \left(\frac{R_1}{R_1 + L} \right)^2 - \omega^2 (R_1 + L) \right) \qquad (4)$$

The solution of equation (4) is:

$$a = a_0 \exp\left[\left(\frac{\rho L}{\sigma} \right) \left(\frac{g_1 R_1}{R_1 + L} - \omega^2 \left(R_1 + \frac{L}{2} \right) \right) \right] \qquad (5)$$

Equation (5) is the expression which yields the required taper ratio for an orbiting, non-rotating, tether skyhook of any given length, L. It can be seen that the tether taper ratio is an exponential function of the material density to system ratio, ρ/σ, multiplied by a the length of the tether, L, multiplied by a term which decreases strongly as the angular velocity, ω, increases.

It can be shown from the laws of orbital mechanics that:

$$(R_1 + L)^3 = \mu / \omega^2 \qquad (6)$$

where μ is the mass of the Earth times the universal gravitational constant. Until such time as either of those quantities should change, $\mu = 398600$ km^3/s^2.

Now as the velocity of the tether with respect to the ground increases, so does ω, which, as equation (6) shows, has a strong inverse relationship to the length of the tether from its bottom tip to its thickest (orbital center of mass) position. As equation (5) shows, *each* of these effects tends to reduce the required tether taper ratio *exponentially*, so it may be expected that taken together, the resulting reduction in required taper ratio will be extremely strong. As we shall see in the presentation of results given below, this is indeed the case.

A tether skyhook starts with a certain cross-sectional area, a_0 at its base, which increases to a maximum cross-sectional area at its orbital center of mass. The ratio of the maximum area to a_0 is called the tether's "taper ratio." The tether then continues outward beyond its center of mass, tapering off again as described by equation (5), or faster. In general there will be an upper strand to the skyhook system which will extend outward beyond the orbital center of mass by a distance at least as great as the lower tether strand.

Discussion of Results

The strength to weight ratio of tether materials is ordinarily given in terms of the tether's characteristic velocity (U), which is simply the square root of the strength (in pascals) to density (in kg/m^3). ($U = \sqrt{(\sigma/\rho)}$) Kevlar with a U of 1.2 km/s has been available on the commercial market for some time, while

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state-of-the-art high-strength kevlar type materials with a U of about 1.6 km/s are now becoming available. Advanced materials with U's of somewhat over 2 km/s will probably be available in the near future.

Fig. 2 shows the taper ratios resulting from equation (5) for hypersonic skyhooks with U's of 1.2, 1.6, 2.0 km/s. The case of a ground-track velocity of zero is simply the classic Artsutanov-Pearson geostationary skyhook. It can be seen that, postulating present day or near-future materials, such devices require taper ratios that are astronomical, making their construction infeasible.

The merit of allowing the skyhook to move at hypersonic velocities can, however, also be seen. For example, assuming a U of 1.6 km/s, the geostationary skyhook requires a ludicrous taper ratio of 10^8, while one whose base is allowed to move at 4 km/s (Mach 12) only requires a quite reasonable taper ratio of 10^2.

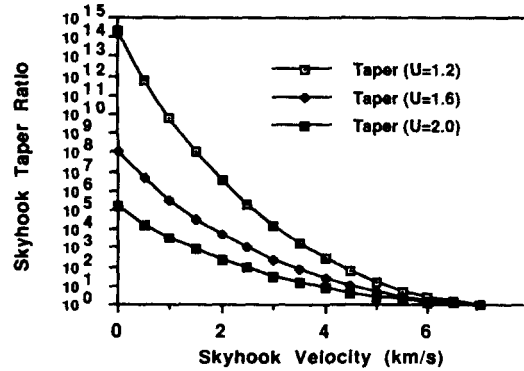

Figure 2: Taper Ratio for Hypersonic Skyhooks

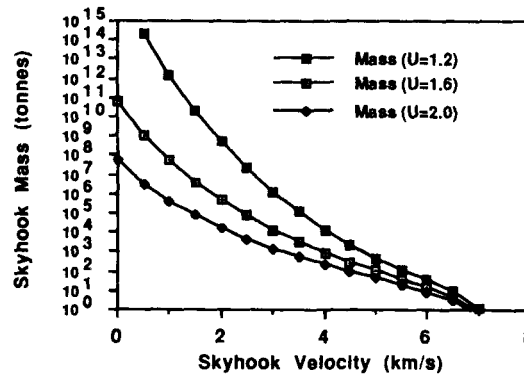

Figure 3: Mass of Hypersonic Skyhook Tether Lifting 4 tonne Payloads

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Fig. 3 shows the mass of a hypothetical skyhook system capable of lifting loads of 4 metric tonnes. The skyhook mass was estimated by integrating equation (5) from the bottom of the tether to its orbital center of mass (to calculate the mass of the lower tether directly), doubling this account for the additional mass of the strand of the tether beyond the orbital center of mass (this is an approximation—there is a certain amount of design freedom in the configuration of the tether upper strand), and multiplying the result by 1.25 to allow for margin. Once again the drastic reduction in mass of the hypersonic skyhook compared to the geostationary variety is readily seen.

Table 1 gives the lower tether length (100 km less than the skyhook central platform orbital altitude) and the total tether mass (both upper and lower strands) for hypersonic tether skyhooks capable of lifting one tonne loads, again with a safety margin of 1.25. It can be seen that while a geostationary skyhook with a U of 2.0 km/s requires a total (upper and lower sections combined) tether mass of more than 13 million tonnes, a hypersonic skyhook with a ground track velocity of 5 km/s only requires 11 tonnes of tether mass.

Also shown in Table 1 is the energy measured in units of "C3" the payload will have if released from the upper end of the tether, assuming that the tether is constructed symmetrically, with the upper strand identical to the lower strand. (The C3 of an orbiting spacecraft is the difference between the square of its velocity and the square of the planet's escape velocity at its altitude) Since a C3 of $8 km^2/s^2$ is about what is required for a minimum energy trajectory to Mars or Venus, after which a planetary gravity assist can be obtained, it can be seen that a hypersonic skyhook with a base velocity of 4 km/s or less can be used to transfer payloads from a suborbital condition to a trajectory to any planetary destination in the Solar System. While it cannot achieve Earth escape, a payload released from the 5 km/s skyhook has more than sufficient energy to achieve an elliptical orbit whose apogee is at geostationary altitude (i.e., a GTO orbit).

A Hypersonic Skyhook System

Let's now take a look of what a sample early skyhook system might be like.

Table 1: Hypersonic Skyhook Performance for tonne Payloads

Velocity (km/s)	Lower Length (km)	Skyhook Tether Mass (tonnes) U=1.2	U=1.6	U=2.0	Upper End C3 (km^2/s^2)
0.0	35727	3.68×10^{16}	1.40×10^{10}	1.34×10^{7}	21.9
1.0	13275	3.23×10^{11}	1.26×10^{7}	102,250	32.1
2.0	7501	1.22 E 8	117,000	4200	30.0
3.0	4667	325,000	3,425	375	21.4
4.0	2936	3,575	224	55	8.1
5.0	1751	122	26	11	-8.8
6.0	880	31	3.8	2.1	-29.1
7.0	208	0.33	0.19	0.12	-52.4

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Based upon the results given in Table 1, we'll assume a 1.5 tonne payload delivery design with a ground track velocity of 5 km/s and U = 2.0 km/s. The required tether thus has a mass of 16.5 tonnes. A power source will also be required to lift the payloads up the tether by a cable car mechanism; 30 kilowatts should do it. This can be provided by either photovoltaic panels or a nuclear reactor. Assuming near term space technology, this will have a mass of 2 tonnes for the power source and its power conditioning system. While moving up the lower strand of the tether, the 1.5 tonne payload has an initial weight of about 7800 N (the weight is reduced by centrifugal force), decreasing to 0 at the orbital center of mass. If we assume an average weight of 4000 N, the average speed that the payload can be moved is (30,000 W/4000N) = 7.5 m/s. Since the lower strand of the tether is 1751 km long, it will thus take about (1751000/[(7.5)3600)] = 65 hours to move the payload from the tether lower tip to orbital altitude at the skyhook center of mass. Raising the payload beyond the orbital center so that it can be released at some point along the upper strand of the tether requires no power at all, as beyond the orbital center of mass, the outward centrifugal force term along the tether is greater than the inward pulling force of gravity. Effectively, a payload being transferred out along the tether upper strand is being lowered away from the Earth.

While the bottom of the tether has a ground-track velocity of 5 km/s, it has a velocity of 5.471 km/s with respect to a fixed (non-rotating) Earth (assuming a tether bottom altitude of 100 km.). The tether center of mass is moving at a velocity of 6.96 km/s with respect to a non-rotating Earth. Moving a 1.5 tonne payload from the tether base to its orbital center of mass thus increases the payload's angular momentum about the Earth by (6.96*8229) − (5.471*6478) = 21883 tonne-km^2/s. Since the angular momentum of the total skyhook-payload system about the Earth must be conserved, thrust will be required or the skyhook will lose altitude. If we adopt the approximation that the total mass of the skyhook (about 20 tonnes, accounting for various miscellaneous subsystems and micrometeorite protection) is concentrated at its orbital center of mass, we find that a total ΔV of [21883/(20*8229)] = 0.134 km/s will be required for the tether to maintain altitude. If this is provided by ion engines with a specific impulse of 5000 s, then 54 kg of propellant will have to be expended to enable the skyhook to maintain altitude after the lifting of each 1.5 tonne payload. Alternatively, part of the tether could contain an aluminum wire, whose current, interacting with the Earth's magnetic field could be used to produce thrust without the expenditure of any propellant. Based upon existing studies[7], a 20 km long electromagnetic (10 km above the orbital center of mass and 10 km below) tether operating in an equatorial orbit at an distance from the Earth's center of 6,778 km and consuming 30 kWe would have a mass of

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about 800 kg and be able to generate a thrust of 3.75 N. Our skyhook operates in an equatorial orbit at a distance from the center of the Earth of 8229 km, and since the Earth's magnetic field falls off as the distance from its center cubed, this implies that such a design would exert a thrust of 2.1 N if used to propel the skyhook. This amount of thrust would be sufficient to provide the required compensatory ΔV for the skyhook in about 15 days. If more frequent use of the skyhook were desired, part or all of the ΔV could be provided by lifting a high thrust propellant to the orbital center of mass as part of the payload. For example if hydrogen/oxygen propellant with a specific impulse of 450 s were used to provide half of the required 134 m/s ΔV, then 306 kg of the 1500 kg payload would have to be propellant, but the tether could provide the rest of the re-boost electromagnetically in a period of 7.5 days, thus allowing it to be used about 40 times per year.

The skyhook system could be made safe from severance by orbital debris by using a multistrand configuration such as that recently proposed by Robert Forward[8].

Payloads would be delivered to the skyhook by a trans-atmospheric vehicle, perhaps similar to the National Aerospace Plane (NASP) or Single Stage to Orbit (SSTO) vehicles currently being developed. Vehicle performance requirements would be far more modest, however, since only suborbital (Mach 15) flight would be needed, instead of the Mach 25 speeds entailed for both flight to orbit and orbital reentry. The trans-atmospheric vehicle would match speeds with the skyhook bottom (which is hanging at an altitude outside of the tangible atmosphere), and use vertical thrusters to negate gravity during the period of rendezvous. During rendezvous the trans-atmospheric vehicle would hover below the tether, open its cargo bay, and allow its payload to be hooked by a cable car mechanism which rides upon the tether. After the payload is hooked, the trans-atmospheric vehicle would drop away, close its cargo bay, and return to Earth.

Assuming the 30 seconds of thrust-negated gravity are required for the hooking operation, and hydrogen/oxygen thrusters with a specific impulse of 450 s are used, then an amount of propellant whose mass is about 3.3% of the trans-atmospheric vehicle will have to be expended during rendezvous. The amount of fuel used is only 3.3%, not 6.6%, because a suborbital vehicle flying outside the atmosphere at a ground track velocity of 5 km/s only experiences about half of the Earth's gravity. (This suggests another interesting use for hypersonic skyhooks: use them to suspend non-rotating, partial gravity space stations. Such stations could be used to train crews or test equipment under simulated Lunar or Martian surface gravity conditions.)

Using its own electrodynamic thrust capability, the skyhook could deliver itself from LEO to its design altitude of 1851 km in about 86 days,

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without requiring any propellant. The system's total initial mass in LEO would thus be the same as its operational mass, i.e. about 20 tonnes, and either a Titan IV or a space shuttle could lift it to orbit in a single launch.

Each 1.5 tonne payload lifted to the base of the skyhook would be delivered not merely to orbit, but, by running out along the upper tether of the skyhook system, could be placed on a GTO trajectory. The delivery of 1.5 tonnes of GTO represents an equivalent capability to that represented by a Delta/Pam launch vehicle and upper stage combination, which has a ground lift-off mass of 220 tonnes, and a cost of $60 million. A single stage suborbital rocket using H_2/O_2 propellant with a trajectory averaged Isp of 420 s and a stage dry mass fraction of 20% that could deliver the 1.5 tonne payload to the skyhook base (6 km/s ΔV assumed), hover for 30 seconds, *and land*, would have a ground lift-off mass of 25 tonnes. Thus the skyhook aided system would only have a lift-off mass 11% that of the Delta, and could be fully reusable as well. Savings per mission would probably exceed $55 million, with financial break-even against the $130 million required for the initial skyhook Titan launch exceeded on the third suborbital launch.

Storming Heaven

The near-term hypersonic skyhook described above can thus reduce the cost of launching medium-sized satellites by about an order of magnitude, but in the longer term, it represents something far more important. *The skyhook is a beachhead for the storming of heaven.*

Let's see how this could work. The skyhook described above has a mass of 20 tonnes and can assist in the lifting of 1.5 tonnes to orbit per suborbital launch. This means that in 14 launches of a reusable suborbital vehicle, the mass of the skyhook can be doubled. If the parts lifted to orbit are simply a parallel skyhook system, the two can be made to work in tandem and we now have a skyhook capable of lifting 3 tonnes to orbit per suborbital launch. The skyhook's capability has been doubled, and the total ground lift-off weight of the 14 reusable suborbital launches required to double it, about 350 tonnes, is less than half that of the 850 tonne expendable Titan IV (or 2,000 tonne partially reusable Space Shuttle) required to launch the initial system. Using 14 launches of a larger suborbital vehicle, with a ground liftoff weight of 50 tonnes, the skyhook can now be increased to a system with the capability of lifting 6 tonnes per launch, with similar savings. We could go on like this, simply using the leverage offered by the 5 km/s skyhook to double its capacity with every 14 launches, or we could use some of the mass lifted to extend the skyhook so that instead of requiring 5 km/s ground track velocity for the suborbital launcher, only 4 km/s will be needed. If the ΔV required to achieve orbit is dropped in this way, the payload delivery capability of the suborbital system will be doubled. This will cut in half the cost of delivery of all further mass to orbit.

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This is only the beginning. As the skyhook continues to operate in support of its own expansion, the mass of payloads deliverable to orbit can be made to increase exponentially, while the costs of delivery drop in inverse proportion. As the skyhooks are lengthened to allow for flight to orbit at lower and lower velocities, the delivery of *large payloads* to orbit using hypersonic *airbreathing* systems will become increasingly practical. Within a comparatively short time, transporting people and payloads from the Earth's surface to orbit could become as cheap as long distance jet travel is today.

The golden door to the high frontier will then be wide open—and not just for governments with billions to spend, but for anyone willing to fly. For the teeming masses of humanity, the Space Age will have truly begun.■

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CORRECTION

The short story "Dad," which appeared in our June issue, was written by Bud Sparhawk, not Jeffery D. Kooistra as listed on the table of contents. Our sincere apologies to author Bud Sparhawk for this oversight.

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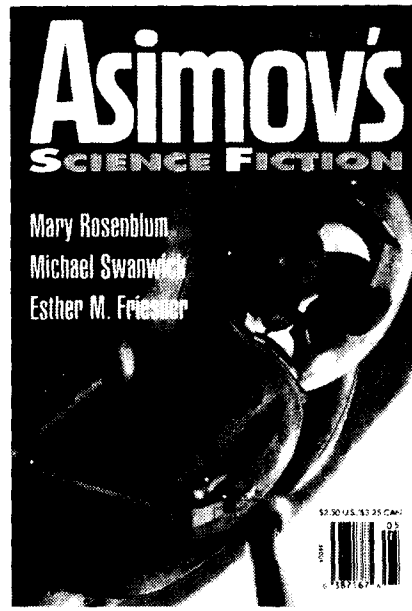

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Daniel Hatch

GENERATIONAL CONFLICT

If you understand the properties of any system, you can probably turn them to your advantage!

Illustration by William R. Warren, Jr.

Alexander von Dobler didn't blink when the crowd in the great hall broke into jeers on his arrival. It was what he had expected. The commission had packed the chamber with their own people.

He just smiled at his niece, Alicia, seated in the first row of the arching gallery. The light of her bright young face was enough to dispel the gloomy [illegible] would grow [illegible] looked at her and [illegible] she would be [illegible] the struggle [illegible] the [illegible] the heavens.

The high table at the front of the hall was still empty, but soon the members of the Planetary Zoning

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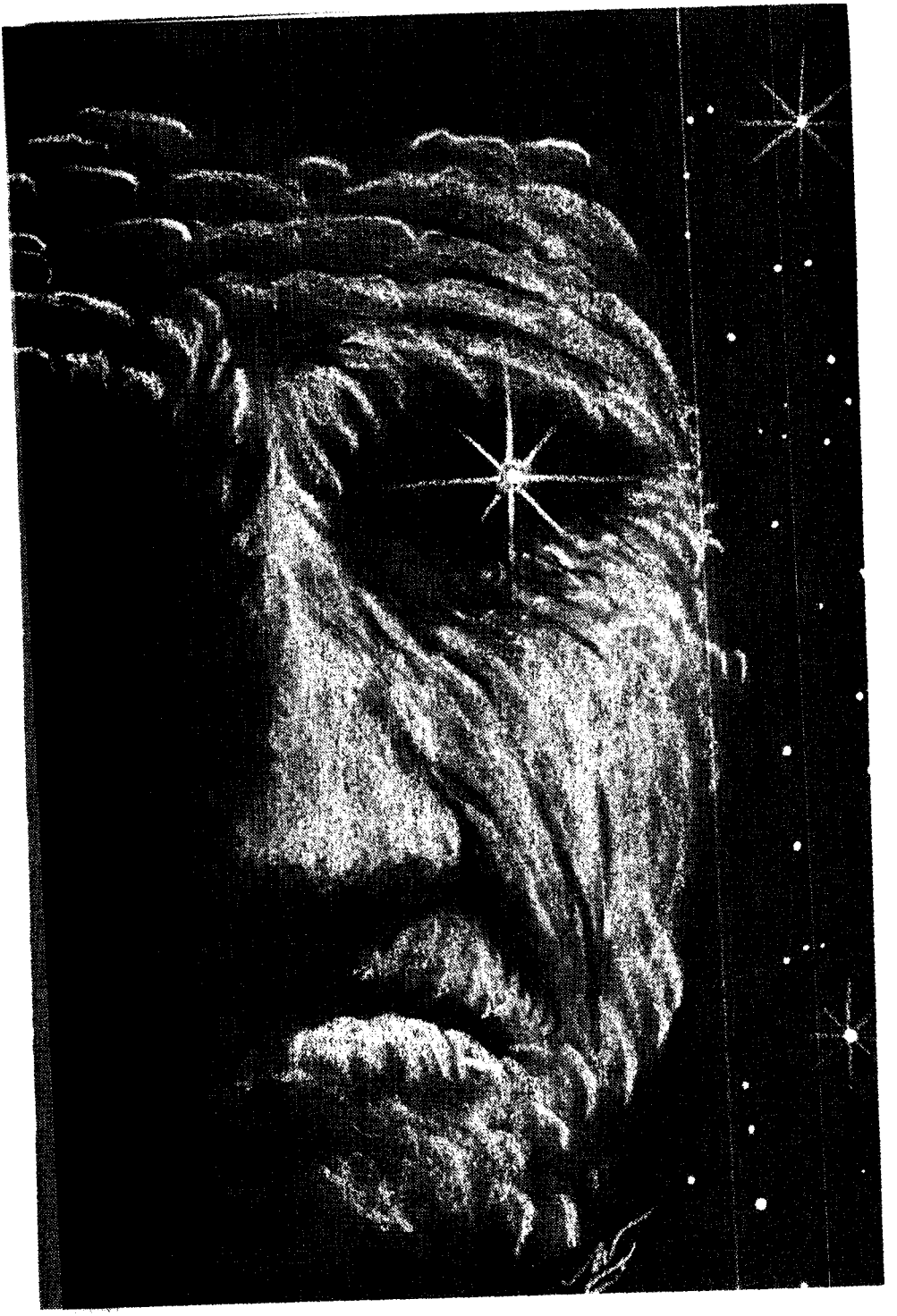

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Commission would take their places and the hearing would begin.

Nearly a thousand people crowded the hall, their murmuring voices filling the air with a loud hum. Floating camera pods hovered above their seats, and giant screens reflected the images of their faces on the wall behind the podium. High above their heads a few bright stars could be seen shining through the clear domed ceiling.

Von Dohlen went to his seat and set his brief-comp on the table in front of him. It would remain there for the rest of the hearing. He would not need it. He knew this case inside and out.

Alicia von Dohlen's face appeared briefly in one of the wall screens, framed by falling blond curls. Her uncle turned his head in time to see her blush. He rose, walked back to the edge of the gallery, and tipped his head up to speak to her.

The elder von Dohlen was one of the greatest attorneys on the entire planet, but his niece was fast becoming his rival. She was his best student.

This case would be Alexander's last—the capstone of a long career. When he first began, he was little older than Alicia. Now his hair was silver and grey with age, the lines in his face were many and deep.

"Keep an eye on Commissioner Russell," he told his niece."His vote could swing the decision. The rest are split evenly for and against."

"I wouldn't be so sure of that, uncle," she replied. "I don't trust Commissioner Kiley for a moment. She can be tricky."

His eyes widened a bit with doubt and he shook his head. "We'll see," he said.

Then a flurry of electronic trumpets echoed from the walls of the great hall, and the seven commissioners of the Planetary Zoning Commission filed solemnly across the floor and up to the podium.

"I declare this public hearing of the Planetary Zoning Commission open," Chairman Russell declared when they had taken their seats. "Madame Secretary, if you would please read the hearing notice."

Commissioner Kiley's face filled the screens on the walls as she read from the parchment on the desk before her. "A public hearing on the application of the New Avalon Development Company will be held at 8 P.M. on Pentember 15th, Standard Year 3465, in the chamber of the Planetary Zoning Commission. The commission will take testimony from the applicant showing cause why the application should not be denied because of violations of Avalon's zoning laws."

"Is the applicant present?" Russell asked.

"Legal counsel is here, sir," the attorney replied from his table. "Alexander von Dohlen at your service."

"Are you ready to present your testimony?"

"Yes, sir. If I may begin. . . ." He rose from the table and the image in the wall screens shifted to closeups of his face from three different angles.

"This is an application for a Special Satellite Use Permit for the New Avalon Development Company, hereaf-

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ter known as the developer. The developer is asking permission to place in orbit around the planet of Avalon an artificial satellite.

"The satellite would have a radius of 50 kilometers and its orbit would average 500 kilometers above mean sea level for the planet. It would consist of a steel shell 100 meters thick formed by explosive excavation of a heated iron-carbon asteroid that would be moved into the aforesaid orbit.

"The developer intends to cover the surface of the satellite with soil and water derived from asteroid and cometary debris and provide it with an atmosphere derived from cometary debris.

"The project, we believe, complies with all aspects of Avalon's zoning code and has received the necessary permits and permissions from the Corps of Planetary Engineers. There are no abutting property owners with standing to oppose the project.

"We therefore request your approval of the application," von Dohlen said, as he took his seat.

The faces of the commissioners filled the wall screens. Russell's bore a great frown nearly three meters wide.

"Is there anyone else who would like to testify?" he asked.

On the far side of the chamber, at a table similar to von Dohlen's, was a thin man with a drooping moustache and a balding forehead. He rose, and his face joined those of the commissioners.

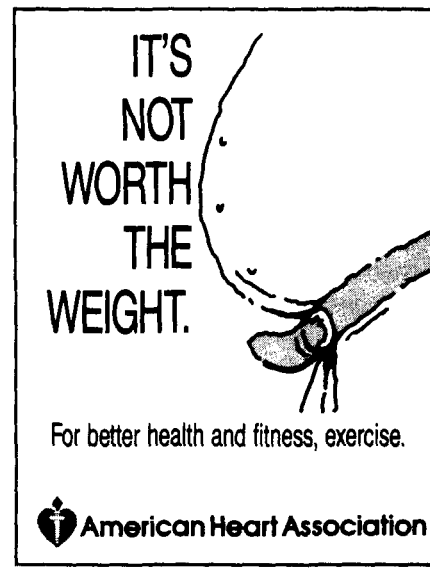
"I would like to say something if I might be allowed, sir," the man said. "For the record, I am Edward Metz, the Zoning Enforcement Officer of Avalon."

"You may speak," Russell said.

"Thank you, sir," he said as he stepped from behind his table to take the center of the floor. He faced von Dohlen from twenty meters away. The camera pods dropped to the floor, and the image of his face suddenly loomed down on the attorney.

"First of all, I would like to object to the use, by the developer's attorney, of the future tense when referring to this project," Metz said in a nasal voice that made the steel frame of the chamber buzz.

"As we all know, the project was completed fifteen years ago. In fact, if you'll all turn your attention to the sky above us, in about five minutes, you should be able to see New Avalon pass by. It will be the bright star moving from the rear of the chamber to-



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wards the wall behind the podium."

The crowd in the gallery growled angrily.

The commission had clearly orchestrated this hearing well—right down to the scheduling, with a time and date that would put the satellite overhead. The attorney had anticipated this, however, and it did not take him by surprise. He just turned to his niece and smiled.

"Your point is well taken, Mr. Metz," Russell said. "The attorney for the developer will refrain from couching his testimony in the terms of what is obviously a legal fiction."

"My apologies, Mr. Chairman," von Dohlen said humbly.

"In fact, that is the main objection my office has to approval of this application," Metz continued. "Every step of the way, the developer in this project has ignored proper application process. Since the project was begun twenty-five years ago, they have proceeded without permission from the commission. They have refused to honor our stop-work orders. They have failed to provide the commission with the engineering data and design specifications for their project. And they have flaunted their violations in the most brazen manner, sending the satellite through the skies over us twelve times a day."

A loud roar rose from the crowd in response to Metz's charge.

"In fact," he went on, "there are advertisements on holovision all day and all night inviting us to vacation on the satellite, orbital ferries travel there six times a day, and more than 100,000 people have taken up permanent residence there."

Once again the crowd shouted in response, until Russell gaveled them into silence.

"Mr. von Dohlen, your testimony sounded so simple. Your project seemed so innocent. But I'm afraid you may have left something out of your description of the satellite your client has placed in orbit around our planet. You say this is a steel shell 100 meters thick. How is that formed?"

"By explosive excavation," von Dohlen responded. "A large iron asteroid is prepared by placing a large quantity of ice at its center. It is heated by large mirrors until the iron is molten. The carbonaceous content of the mass mixes with the iron at this point to make a crude kind of steel. When the mass melts through to the center, the ice turns to steam and explodes.

"The result is a large hollow metal ball, about 100 meters thick and 100 kilometers in diameter."

"So you have a large hollow ball in orbit around our planet. Isn't there something at the center of this ball? After all, it's an awful lot of empty space just going to waste."

"This is a standard method of space construction that has been used since man first moved out into the Home System," von Dohlen said. "The space inside such hollow satellites has been used for a number of purposes, including comfortable living space in a pressurized environment."

"Yes, that's true," Metz said. "But isn't there something in particular inside the New Avalon satellite?"

"There is," von Dohlen admitted.

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"A singularity."

"A singularity? Could you explain what that is in laymen's terms?" Metz asked melodramatically.

"I suppose so," von Dohlen said. "It's what most people call a black hole."

It took a few minutes for the crowd to fall silent.

When they did, Metz continued with his prosecution. He returned to his table, picked up a comp-folder and examined the data displayed on it.

"What is that black hole used for?" he asked.

"It is necessary to provide artificial gravity for the satellite," von Dohlen answered. "The only way to retain New Avalon's atmosphere is to provide it with a surface gravity of some magnitude. The engineering design called for a value of six-tenths of standard gravity. The singularity allows us to maintain that surface gravity without artificial means.

"On top of that," he said, "it provides a power source for the satellite. One of the benefits we offer on New Avalon is unlimited free energy for all residents."

"How was the black hole created?" Metz asked.

"It was generated using a standard star drive," von Dohlen said. "As I understand it, when a star drive is put into reverse, it warps the space around it irretrievably, forming the singularity. In this case, the developer attached the drive to a stony asteroid about 400 kilometers in diameter. That gave us sufficient mass to create the gravitational field we wanted on the surface of the satellite. It's a standard practice accepted by the Corps of Planetary Engineers."

"And they issue permits for the process?"

"Yes, they do."

"Then can you explain why you generated a singularity using that process in Standard Year 3440?"

Von Dohlen smiled sheepishly and nodded. "Yes, I can," he said. "At that time, the process had not been attempted—at least not intentionally. We were the first to apply it to a commercial development. The process was completed under Corps supervision, but I'm sorry to say that there was no permit procedure for us to comply with until five standard years later."

Metz was unmoved. "Where was this done?"

"The initial site preparation work was completed in the asteroid belt—the creation of the satellite shell, the generation of the singularity, the installation of the singularity in the shell."

"And it was moved into orbit around Avalon?"

"Yes, it was," von Dohlen replied without emotion.

"And you had permits and approvals allowing this movement?"

"Well, not exactly," the lawyer said. He waited for Metz to pounce and say, "Aha!" but he did not.

"At the time, there were no application procedures in place in the planetary administration to deal with that kind of operation. I am afraid the regulatory process just couldn't keep

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up with our engineering innovations. I would like to point out, however, that as the permit process was developed, we met the deadlines imposed on us and were granted the necessary approvals—leading up to the application before you this evening."

"But you went ahead with each step of the project anyway? Without the permits?"

"Yes, we did."

"Can you tell us why?"

"We didn't see any reason not to."

It was some time before Russell gaveled the crowd into silence. When the chamber returned to some semblance of order, he asked Metz if he were finished. He said that he was —an obvious bit of orchestration— and Russell asked if anyone else wished to speak.

One more time, the galleries came to life with shouts, catcalls, whistling, and hooting. The chairman of the commission directed one of the camera pods over the assembled mass, pausing before each of them as they testified.

"My wife left me three months ago for that danged place up there," said one red-faced agroworker. "It's their fault for promising free power, free living, and clean air. The air's plenty clean on our farm—'cept when it's fertilizer time."

A second witness was a petite blonde woman with large sunglasses. "I have a real estate business on the South Continent," she said, "And in the last five years, since they started advertising on holovision, our sales have dropped 50 percent. I think it's terrible that they should be allowed to sell property like that without permission."

The face of the next witness filled the wall screens, bearded and eyes wide with agitation. "That thing up there is giving off some kind of radiation," he said with a snarl. "Everything in my garden died off the year after they put it up there. And I've been getting these headaches that won't quit every time it goes over."

The cameras then found the face they had been looking for. An angry woman with perfect skin, piercing eyes, and a penetrating voice. "I represent the Concerned Citizens of Avalon, and we have already submitted a computer petition containing 67,531 names in opposition to the project. We came to this planet to escape the kind of overdevelopment they had back on Ultima Thule, New Polaris, and Nova Terra. I think it's awful that these people are trying to ruin this world just like those.

"I just want you all to know that this is still a democracy, and we are the people," she said with relish. The crowd roared its approval. "We are the ones who elected you, and we want you to do what we tell you to do. If you don't, we'll elect someone else, so you'd better watch out."

That was the cue for her supporters around the chamber to begin a demonstration that went on for several minutes. They waved banners, blew horns, shook their fists, and otherwise showed their contempt for developers, planetary engineers, and anyone else that would threaten a way of life that they had only recently come to

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appreciate.

Von Dohlen knew their type. Most of them were recent immigrants to Avalon. The rest were landowners near the settled areas of the planet who were jealous of a project that forced land values down before they had a chance to sell.

When the demonstration was over, the cameras sought out more of the demonstrators who wanted to vent their spleen. They went on for another half an hour, listing their complaints, before Russell brought the parade to an end.

"Do any of the commissioners have anything to say?" he asked, looking up and down the long table at the robed men and women.

"I have a few questions," said the woman on the end. Dorothy Kiley's sharp features filled the screens on the walls behind the commissioner. "Mr. von Dohlen, aren't there any safety concerns associated with your black hole?"

"I believe there are quite a few," the attorney replied. "But our engineers have taken care to design countless safety features into the project."

"What about radiation?" she asked. "I believe one of the citizens mentioned that as a fear. What have you done about that?"

"There is some radiation given off inside the satellite," von Dohlen said. "We feed matter into the singularity to produce power, but only under carefully controlled conditions. The shell of New Avalon, however, is 100 meters thick," von Dohlen said. "That is more than sufficient to shield the radiation given off by the singularity. In addition, much of the radiational energy it produces is used to power the project's energy systems."

The towering face peered down at the aging lawyer. Her eyes narrowed. "Mr. von Dohlen, can you tell me what would happen if New Avalon's orbit were to deteriorate? If the shell were to break up, and the black hole hit the surface of our planet?"

Von Dohlen remained cool. He had been expecting this question sooner or later. He looked back over his shoulder at his niece, who smiled smugly and shrugged—her way of saying, "I told you so."

He began with a steady voice and a somber expression.

"I assure you that the chances of such an accident occurring are infinitesimal. The star drive machinery installed in the satellite is entirely capable of maintaining its current orbit or transferring to a new one. The singularity itself produces more than enough energy to power those drives. As long as there are engineers on New Avalon, we will always be able to keep a safe and steady course.

"But in the highly unlikely event that a series of disasters cripples the ability to maneuver New Avalon, what you describe could occur," he said.

"I'm afraid I must be brutally frank with you in describing such an eventuality. The results would not be beneficial. The shell would break up on contact with the atmosphere. The singularity would continue on unaffected, passing through the atmosphere and the surface of the planet

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unhindered.

"For an object as dense as this, ordinary matter poses no more of an obstacle to motion than a vacuum. As it passed through the atmosphere, the singularity would give off a great deal of radiation—lethal within several miles of its passage.

"While the consequences for this world may not be pleasant, the true victims would be the residents of New Avalon themselves—people who have decided to take the risk of living there on their own."

Kiley frowned. "Whether they have decided to take that risk or not, Mr. von Dohlen, it is the responsibility of this board to decide if the risk is too high to allow anyone to take."

"Are there any other comments?" Russell asked, looking up and down at his colleagues.

When there was no answer, he continued, "Well, I have some."

His face grew stern. Each of the several views in the wall screens turned to display his grey countenance. The chamber fell silent.

"Mr. von Dohlen, you have made a very slick presentation. But you are a lawyer, and my father once said lawyers could find a loophole in the law of gravity if you give them enough time.

"But judging by what you've said about the effect of that satellite coming down, you'll have to do that before you convince me to vote for the approval of this project. No matter what you say, some day, somehow, that thing can break down. The engineers can mutiny. The orbit can decay. Nothing, Mr. von Dohlen, lasts forever.

"I'm not going to say too much about the fact that you've put that thing there without getting the proper approvals. Most of the people who let you get away with that are residents of New Avalon today, so I guess that speaks for itself. But I and the other members of the board were elected to this position because we promised that would not happen again.

"What bothers me is that you have prolonged this process by an unimaginable period of time. This project has been going on for twenty-five years! The cost to the planetary administration has been astronomical. It has been the interminable fact of life for this commission and many others. The pain and suffering you have inflicted on the government of Avalon is unconscionable."

The chairman leaned back in his seat and rubbed his eyes with one hand.

"I'm going to call for a vote now, unless there are any objections." No one spoke up as the secretary, Commissioner Kiley, read the roll call. One by one the faces of the commissioners appeared in the wall screens as their names were called.

"Miller?"

"Aye."

"Sanderson?"

"Nay."

"Steelax?"

"Aye."

"Russell?"

"No."

"Borman?"

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"No."

"Tortelli?"

"Aye."

She looked down the length of the table. The tension was high, and she paused for a moment to let the suspense build. "And the secretary votes no. The vote is three in favor, four opposed. The permit is denied."

The tumultuous cheer of the crowd filled the chamber and drowned out the sound of Russell's gavel as the hearing was adjourned. A few of the spectators jeered at von Dohlen, but he barely noticed them. He went, instead, to the edge of the gallery and his niece.

"I'm sorry, Uncle Alex," she said.

The elder von Dohlen smiled bravely. "It's all right, my dear. We both knew how it was going to come out. The deck was stacked against us."

She sighed and shook her head. "Even so, it's a shame that a long and successful career had to end with a defeat."

"That's true," he replied. "But I know I'm leaving the case in good hands. After all, this is only the first round. We may have lost here, but who knows what will happen when you take it to the Zoning Court of Appeals."

His face broke out into a broad smile that deepened all his many wrinkles. "It may even take another twenty-five years." ■

ANALOG
SCIENCE FICTION AND FACT

congratulates the winners of the 1992 Nebula Awards

given by the Science Fiction and Fantasy Writers of America

Best Novel
Doomsday Book
by Connie Willis

Best Novella
"City of Truth"
by James Morrow

Best Novellette
"Danny Goes to Mars"
by Pamela Sargent
(Asimov's, October '92)

Best Short Story
"Even the Queen"
by Connie Willis
(Asimov's, April '92)

Grand Master
Frederik Pohl

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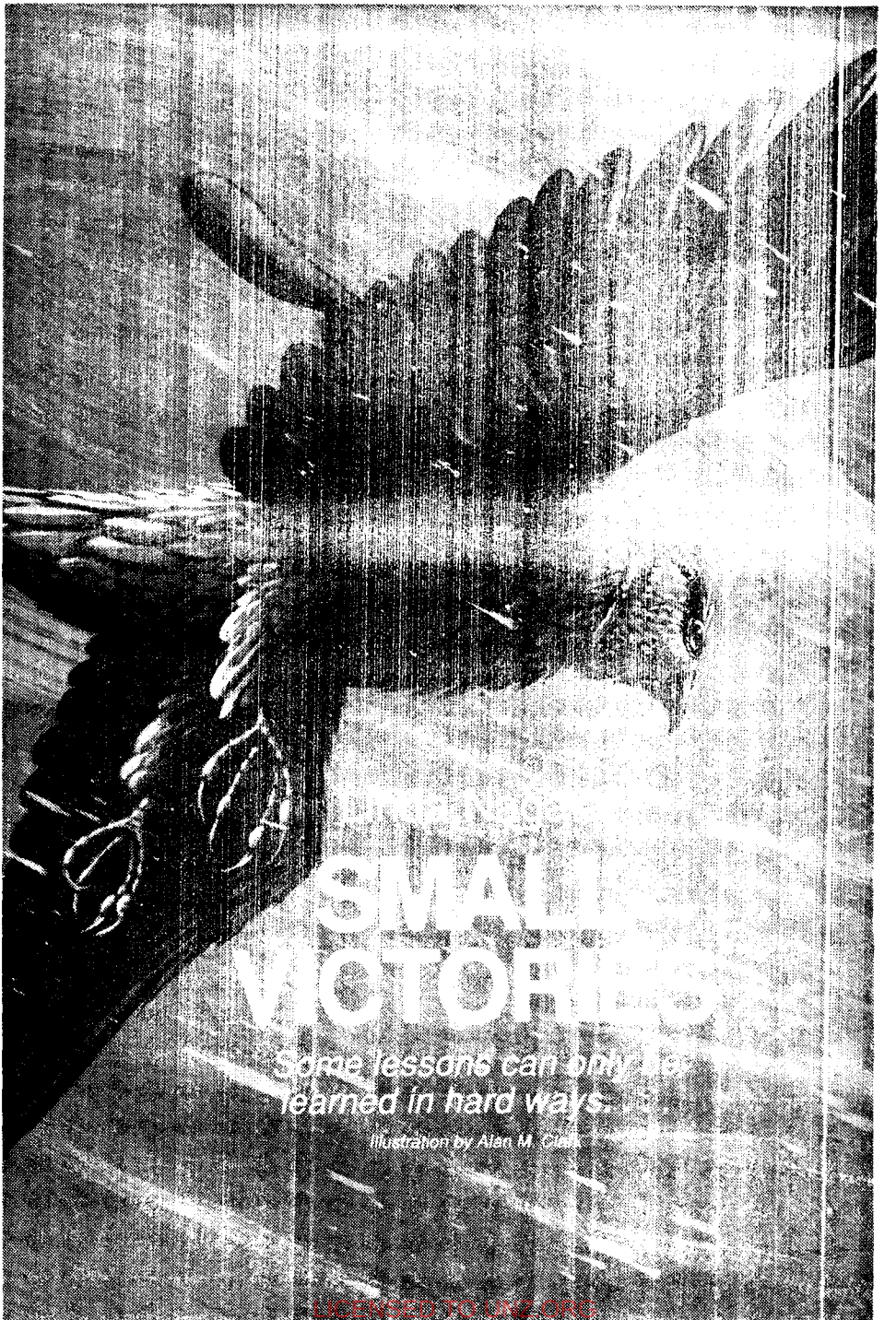

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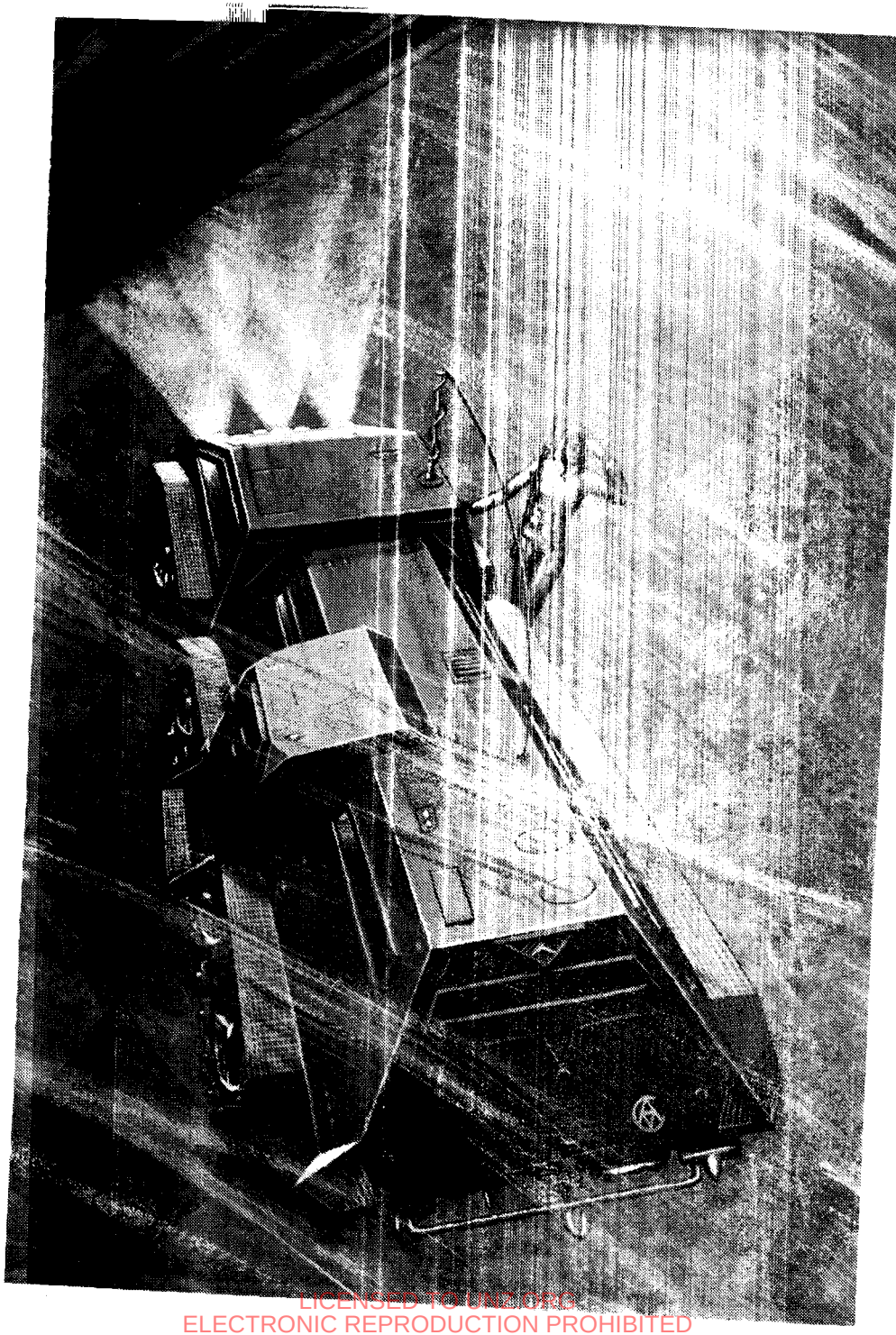

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(1)

Puma's hawk sighted the stranger on a cold morning when the wind off the Barrens had eased just enough to allow the blowing curtains of dust in the lower atmosphere to settle to the ground. "Hey, there's somebody out there," Puma called, his adolescent voice cracking in surprise.

A throat mike picked up his words and cast them to Jynis on the sage flats below. She switched off the torch she'd been using to weld a cracked seam on the sand-blasted cabin of the half-track and glanced up. Puma was crouched on a flat rock above the field station, studying the display on his pocket computer. An implant on the hawk's optic nerve transmitted what the bird saw to the computer, where it was translated into an image that had meaning to a human mind.

"Geology team?" Jynis called curiously. Paris Ridge was a remote field station, far to the north of the City of Necessity, and they had few visitors. Just the occasional geologist, or sometimes an army scout out to patrol the border.

"No way," Puma said. "On foot and in trouble. Face down in the sand. Look."

Jynis set down the torch and slipped her own pc from a hip-holster. She opened it. On-screen was the fractured landscape of Paris Ridge as seen from a great height. She made out the scattered white shapes of her oryx herd moving slowly down a ridge. The sight of the animals reminded her that she needed to get out there this morning, give the experimental antelope their weekly supplementary feeding—

There! Jynis finally found what had caught Puma's eye. Almost lost against a background of scattered stones and sparse native grasses—a tiny, prostrate figure in a camouflage suit of desert rust, an air-pack strapped to his back. The skin on the nape of her neck prickled under a sudden sense of peril. "Gotta be a truck, Puma."

"Don't see it."

Wind hissed past the corners of her respirator and tugged at her dirty white parka. Puma's voice arrived over her earphones. "Better hurry."

"Sure." The native air was thin and mean. If the stranger's oxygen tanks were empty, he wouldn't last long.

Jynis walked from behind the 'track into the full force of the wind. "Storm blowin' up again," she observed.

The field station was situated high on Paris Ridge, on a long slope overlooking the rising swell of the Barrens. Wind-driven plumes of red sand drifted across the lifeless plain. A lowering sun burned dully through the dust-laden skies. They could shelter safe from any sandstorm in the field station—the artificial cave had been dug back into the hillside so that only the outer door of the airlock was exposed—while in the half-track they'd be vulnerable. "How far you make it?"

"Seven miles," Puma said. "Maybe thirty minutes."

Jynis nodded. "Call Hobo Flats. See if they know something." Then she switched off her throat mike. "Shani!" she called. "Shani, come to mama."

Shani had been playing with pebbles she'd found around the roots of

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the introduced sage. Now she toddled toward her mother, awkward in her padded suit, her exposed cheeks chapped red by the wind. Jynis reached down to pick her up. "We're going for a ride," she said.

Shani grinned and grabbed at the mask of Jynis's respirator. With an angry hiss, Jynis jerked her head back out of reach. "*Don't touch!*" she snapped.

Baby Shani didn't have a respirator. Neither did thirteen-year-old Puma or any of the other kids conceived in Necessity. They'd been deliberately designed to suit the native air, gifted with respiratory systems completely adapted to the miserly atmosphere of this cold desert world. Never for them the burden of an air-pack.

"No answer from Hobo Flats," Puma called.

"Try again later." Jynis wasn't concerned. Radio reception was a chancy thing. Ridges and gullies blocked the signal. Sandstorms blew the antennas down. One satellite in synchronous orbit might have solved most of the problems, but manufacturing a satellite and the rocket to launch it was far beyond the reach of the divided and warring colonies. Too much had been abandoned at landing. Whole histories, whole technologies, deliberately destroyed by colony elders determined to leave the old sinful ways behind. Until necessity forced some of them to seek a compromise with their new world.

Puma tossed back the hood of his parka and came bounding down the slope. In the afternoon light his blond hair gleamed faintly pink. Even with his barrel chest, he looked as human as anyone born before the rift. *As human as me*, Jynis thought. Yet he owned something no one before his generation ever had: a third lung. An organ of reduced size, densely packed with alveoli that combed the air for sparse oxygen molecules with the efficiency of a dust miner filtering storm clouds for gold.

Jynis breathed in the bitter, plastic taste of her respirator. She would never have Puma's and Shani's advantages. She'd been conceived in Iyusha nearly eighteen years ago, before the rift, before the civil war, before a dissenting faction of colony elders had decided that their children must *evolve* if they were to have any real hope of long-term survival on a world so unkind.

Jynis pounded a touchplate on the side of the half-track and the airlock snapped open. "You want to ride outside?" she called to Puma.

"Yeah."

Shani wriggled impatiently while the lock cycled, then they were inside the truck. Jynis helped Shani out of her gloves and parka, then strapped her into her seat. Gazing at the child's dark brown hair and wide eyes, she couldn't help thinking of Shani's father. But Greg had been dead two years, murdered on the border by Iyushans even before his daughter had been conceived.

Jynis gave Shani a quick kiss on the forehead, then settled into the driver's seat and started the engine.

The Paris Ridge oryx herd had reached the stranger first. The geneti-

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cally modified antelope were nosing at the body when Jynis brought the truck to a stop. The rising wind that ruffled their thick white fur had already half-buried the stranger's legs in fine red sand.

Jynis wasted no time. Leaving Shani in the truck to finish her nap, she threw on her air-pack and respirator and headed for the lock. By the time she got outside, Puma had already pushed his way through the oryx herd and was crouching over the body. The hawk was perched on a nearby rock, its wings partly spread to balance it against the wind.

Jynis hurried forward, poking gently at the flanks of the milling oryxes to get them to move out of her way. Their long, straight horns flashed in the light as they nuzzled her for food. She'd hand-raised most of them at the field station, and they associated human scent with handouts. Usually she enjoyed their attention. But today their supplementary rations were due and they knew it. They mobbed her, blocking her path, their sharp hooves stomping on her booted feet.

"*Shaw!* Move!" she shouted, waving her hands to shoo them back. Their heads bobbed aggressively; they stood their ground. So she whipped out her pc, entered the oryxes' frequency, and tapped in a code that would stimulate the hormonal implant that each animal carried, calling for a mild case of the jitters.

The white antelope responded almost immediately. Their aggressive behavior stopped. A few snorted nervously, and then the entire herd began to move slowly away. Jynis bounded forward, then dropped to her knees at Puma's side.

The stranger lay face down, unmoving. A blue tinge discolored his cheeks; his lips were pale. He'd torn off his respirator. It was still in his hand, the straps tangled. "He alive?" Jynis asked.

Puma shrugged. "Sort of. Hypoxic. Air-pack's empty. Know him?" Puma swept back the man's long black hair so Jynis could see his features. She caught her breath. He was a young man, probably in his late teens, with rough, chiseled features and a fresh scar across his temple. Jynis felt her heart pounding in her ears. She was sure she'd never seen him before, and that could mean only one thing.

"Looks familiar," Puma announced.

"Oh yeah?" Jynis could feel her anger building. Reaching under the stranger's collar, she felt around for a moment, then pulled out a necklace. On the short, heavy chain hung a deep purple enameled replica of the Iyushan lily. "Since when are you familiar with Iyushans?"

Puma drew back like a cat that had encountered a fetid smell. He plucked at her arm, pulling her back. "Come on. Let's go."

She shook him off. "Uh-uh."

"Leave him!" Puma shouted, startling the hawk into flight. "We don't owe him anything."

"No," she growled. "But he owes us." She yanked on the chain, feeling her hatred like a heady wine. "Bet he was planning on making targets out of us, Puma. Sit up on that ridge over the station and pick us off as we come out the door. But he miscalculated.

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Ran out of oh-two. Too bad."

"Come on, Jynis," Puma pleaded.

She could hear the fear in his voice, but it meant nothing to her. "Look at him. He's old enough. Been a soldier a few years now. Think maybe he's the one that got Greg?" Her grip on the chain tightened. She twisted it around, wanting to choke the last air out of this son-of-a-bitch, wanting to do it for Greg, and for Shani, who would never know her father.

"Jynis!" Puma shrieked.

She gasped and dropped the chain. Puma was staring at her, terror in his eyes. She looked away. "Help me get him into the truck," she said gruffly. "They'll want to interrogate him at Necessity . . . before they hang him."

Visibility had dropped to twelve meters; the half-track's cabin was filled with the hiss of blowing sand. Jynis drove grimly, talking to Puma now and then to make sure he was all right. She'd brought the hawk in and chained it to its perch in the back of the truck. But Puma was harder to control. He'd insisted on riding outside despite the weather. She'd tried to persuade him to come in, but he refused to share air with an Iyushan. *Little prig*, she thought. *And where do you think you'll sleep tonight?*

They'd laid the stranger on a bunk in the half-track's pressurized cabin. Jynis had lashed his hands and feet to the bed frame, then strapped a respirator over his nose and mouth, locking down the demand button so the oxygen would flow free. She waited just long enough to see a flush of color rise in his cheeks before hurrying forward to start the journey home. Shani still slept in her seat, oblivious to the sound of the wind and the rough terrain.

"So someone really did find me in time." She jumped at the unexpected voice. "Or are you an angel bearing me up to heaven?"

A glance over her shoulder showed her the Iyushan in his bunk, propped up on his elbows, his hands and feet still firmly secured. He'd worked the respirator down around his throat. His hard, chiseled face was pinched with exhaustion.

"The name is Jynis Ngutavai," she said, her gaze fixed on the rough terrain ahead. "Of Necessity."

"Cuvey Dubuisson. I've come a long way to find you, Jynis."

Dubuisson? Her knuckles went white on the steering wheel. She felt a prickly sweat break out on her cheeks. "Cuvey . . . Dubuisson?"

"I think you know my mother," he said sadly. "I don't."

She felt her mouth go dry. The words did not want to emerge, but she forced them. "Are you . . . ?"

"I'm your brother. Jynis, I was afraid you wouldn't even know my name."

She touched her throat mike with a trembling hand. "Gotta stop a minute, Puma. He's puking."

"Need help?"

"No. Take a minute."

She brought the truck to a halt, set the brake, unfastened her safety harness. Then she slowly turned around, taking another look at this stranger.

Mother had talked about Cuvey. He'd been two years old when the

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original colony broke apart. She'd left him and her husband in Iyusha, stealing away with the other radicals while Jynis was only a cluster of dividing cells in her womb.

Looks familiar, Puma had said. Sure, Jynis realized. Looked like herself in masculine issue.

"Why come here?" she asked, her voice sharp with suspicion.

"To see you, Jynis." In the back of the truck, the hooded hawk moved restlessly on its perch, its feathers rustling softly. Cuvey's head snapped around at the sound. He half-ducked, and a stifled cry escaped his lips.

Jynis caught her breath, then quickly looked away. An unpalatable combination of embarrassment and fear made her voice harsh. "You running from the war?"

"No!"

She could hear him breathing in deep, shaky gasps. But she wouldn't look at him. She kept her eyes carefully averted. This kind of fear was a private thing.

"I'm still in it," he growled. "I'm going back. I just wanted to see you, that's all."

"Why?"

"You my sister or not?"

She finally looked at him again. He nodded, his face a mask of tension. "I'm not here to hurt you," he said. "I'd never hurt you. You don't need these straps." He nodded at the bindings on his hands and feet.

She glanced at the straps, feeling a faint flush in her cheeks. "Why no truck?"

His gaze shifted. He seemed to be searching for an answer. Then: "I'm AWOL," he blurted. "Iyusha doesn't know I'm here." He looked up. His gaze locked onto hers with an intensity that made her shiver. "My buddy Royce, he heard your name on the radio. He and Fa'a . . . they said they'd cover for me if I wanted to come see how you were doing. But I couldn't get a truck. So I walked."

"That's impossible."

"Not with two air packs and a substandard feed of oh-two. I walked all night."

"You didn't make it."

His breathing started to get raggedy again, but he fought hard to hide it. "I did make it. I'm here, aren't I? Now come untie me. There's a girl."

She'd risen from her seat without thinking. Now she moved toward him, her heart thundering in her chest. She crept to the foot of the bunk where she'd secured him, fascinated by his presence. She saw herself in his eyes. She tried to see her father. She'd never seen her father. *Dubuisson.*

"Free me, Jynis."

She touched one of the straps, but caution still held her back. "Why risk it?" she asked, surprised by the note of pain in her own voice.

"We're family. That's reason enough."

"It wasn't reason enough for mother and father to stay together."

He nodded sadly. "'S true. But we're not like them, Jynis. We're not like them. Come. You don't want to see your own brother hanged?" He gazed at her, his eyes dark and unreadable. There was much that he wasn't telling. She knew it. But she

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gave in anyway. She'd dreamed about him so many years.

Leaning forward, she cautiously unstrapped one of his hands. She half-expected him to go for her then. But he only reached slowly over to undo the other straps. She backed away a few steps, even so. This was treason. The elders at Necessity would unhinge if they knew. The thought secretly delighted her. Discipline in Necessity was always so hard.

"Hey, Jynis." Puma's voice came in over her earphones. "Fixed him up? Need to move on. Wind's bad. Sand's thick."

Absently, Jynis touched her throat mike, her gaze fixed on Cuvey as he stood on stiff legs. "Done here, Puma. Ready to move." She switched off the throat mike and spoke to Cuvey. "He won't like it. You go home tomorrow and I'll make it OK."

"Sure. I've got to get back to my unit. Give me a ride part way to the border?"

She nodded, then turned to make her way back to the driver's seat. With her back to him, she felt fear run between her shoulder blades. But he made no aggressive move; only followed her forward docilely enough. She glanced at Baby Shani still sleeping in the shotgun seat. "I'll move her," she muttered.

Cuvey looked at the baby while Jynis unstrapped her. "Whose?" he asked in open surprise.

Jynis snorted. "Mine 'course. Think I run a baby-sitting service way out here?" She picked up Shani and cradled her against her shoulder while the little one moaned and smacked her lips. "Wanna let me get by?"

Cuvey stepped out of the way, the surprise on his face turning to suspicion. "How old is she?"

"Year and a half." Jynis set her in the backseat and strapped her in, then turned to look at Cuvey. "You got a problem?"

"You had her when you were fifteen."

"Uh huh."

"That her daddy outside?"

"Huh. Puma. He's a kid."

"Then where's her daddy?"

"You think she doesn't have a daddy, that it? You heard the rumors. You think maybe the elders just shot me up with some anonymous doctored seed?" He glared at her, but he didn't say anything. His face was dark with anger. "Well Shani does have a daddy. Down in the graveyard at Necessity. He was murdered on the border. Maybe by you."

Cuvey looked straight into her eyes. Memories seemed to march across his face like the shadows cast by blowing sand. Then: "Easy, Jynis," he said. "You're putting words in my mouth. I think you're too young, that's all."

She jerked her gaze away. "Sit down. We've got to get going."

He nodded and dropped into the shotgun seat. Jynis moved up to drive, suddenly sure she'd made a serious mistake. No. The mistake was Cuvey's, for coming here at all. A boy's stupid, romantic lark. But the problem belonged to Jynis. Because Cuvey had been right—she couldn't let him hang.

She started up the truck, then

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touched her throat mike. "Secure, Puma?"

"Yeah. Let's go."

She released the brake and started edging the truck down an easy slope.

"That kid," Cuvey said. "Why does he stay outside?"

"Doesn't like the way Iyushans smell."

Cuvey smiled at that. He had a nice smile. Jynis felt her suspicions begin to fade. She turned her full attention to her driving.

The grade was beginning to steepen. She responded by turning the half-track slightly to ease the angle of descent. She could no longer see the ground. The wind had stirred up a mist of fine sand that streamed knee-deep up the face of the slope, hiding rocks and rifts beneath its shimmering surface. She slowed the 'track to a crawl and switched on her throat mike. "Puma, hop down and check out this slope for me. I think I remember boulders—"

"On it."

A moment later he was in front of the 'track, wading through the streaming sand. A soft oath escaped Cuvey's lips. Startled, Jynis glanced at him. He was staring at Puma, his face drawn in disbelief. "That boy's out there without a respirator."

"Yeah," she agreed, letting the truck roll slowly after Puma.

"But . . . how? No one can get by on native air. . . . "

Jynis's brows rose in surprise. "You don't know about our kids? Huh. Guess they're too young to be fightin' you at the border." She nodded at Puma. "But that's what the war's about, Cuvey."

"I-I knew your elders abandoned us because they were not content with their heritage. They wanted to breed a new race of humans—"

"No! Not breed. *Design*."

"Uh huh. I didn't know you'd gone so far."

"Not me," Jynis said bitterly. "I haven't gone anywhere. Strictly ancestral type. Outdated."

Cuvey continued to stare at Puma, as if he still couldn't quite believe it. "He's an artificial man."

Quietly, Jynis said, "They don't tell you much in Iyusha, do they?"

Cuvey hesitated. She felt his gaze, though she kept her own fixed on the slope outside. Then, " . . . *Maybe not.*" The admission sounded pained. Jynis felt suddenly sorry for him—it was no easy thing to discover that your own fine body was seriously deficient when compared to a kid from across the border—and that your elders didn't trust you with that truth.

Jynis felt a need to drive the point home. "Puma's better than us," she said.

From the corner of her eye she could see Cuvey flinch. "Do you believe that?"

"Know it. See it each day. Me 'n you are cripples next to Puma 'n Shani, 'n all the other kids at Necessity. Would be nothing for Puma to walk to the border. That trek almost killed you."

Cuvey had nothing to say for nearly a minute. Jynis could feel him weighing the consequences of what he'd just learned. When he did speak, his voice was hoarse. "Does it hurt you?" he asked. "To be obsolete?"

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Jynis bit her lip. For a moment she almost envied Cuvey. In his world he was as good as the next man. No better. No worse. Part of a whole. Things were different in Necessity, where the elders were struggling to build a world that would never include them.

Ahead, Puma signaled *Right. Right!* Jynis's attention snapped back to him. She was carefully guiding the half-track along the indicated path when the boy disappeared—he was there one moment and gone the next, swallowed up by the swirling sand.

"Puma!" she shouted, then switched on the throat mike and called his name again. There was no answer. Either his equipment was broken, or—

She slammed on the brakes. Loose sand shifted under the treads and the truck started to slide. She threw it into reverse and ground back up the slope to stable footing. Then she shut the engine down and scrambled for her air-pack.

"Puma," she called. "Puma, answer me now." He didn't respond. She found herself breathing hard. "Puma, I'm coming for you. Don't know if you can hear, but sit tight." She wrestled her pack on, then pulled the respirator over her face. Cuvey was right behind her. He found his own pack and disconnected the oh-two feedlines Jynis had rigged on it. Shani started to grumble in her sleep and a moment later she was awake and crying irritably *"Mama-ma-ma-ma. . . ."*

Jynis stared at her in a sudden agony of indecision. She wanted to leave her in the truck. But the truck was parked on a steep slope. If it slipped, or rocked in the wind. . . .

Cuvey seemed to share her thoughts. "You stay. I'll find Puma."

"No!"

He froze. "You still don't trust me? You want me to stay here?" He had the lock open. "But if you don't trust me, you can't leave me with the truck. And if Puma's hurt, maybe you're going to need my help."

Jynis hesitated while the seconds swept past. But she had no real choice. "All right. But first get the rescue pack. There, in the locker." She hustled Shani out of her seat and wrestled her into her parka, while muttering ineffective phrases and comfort to the unhappy child. Then she and Shani, Cuvey and the rescue pack, all squeezed into the lock.

The door closed, and Jynis found herself pressed up against Cuvey, supremely conscious of the hard reality of his body. *My brother*, she thought, and for a moment the little chamber sparked with a sense of unreality.

Then the outer door opened and she was moving cautiously down the slope, a step behind Cuvey, with Shani cradled in her arms.

At the point Puma had disappeared, they found a wind-smoothed gorge, an ancient fault line less than two meters across. Blowing sand obscured the bottom of the crevice. There was no sign of Puma.

They scouted along the rim until they found an outcropping of boulders. Then they took a rope from the rescue pack, tied a loop in the end of

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it and hooked it over a solid-looking rock. Jynis tossed the coil into the gully and watched it spin out. The wind caught it and swept it to one side.

"Now," Cuvey said, shouting to be heard over the wind. "Are you going to climb down with the baby in your arms, or will you let me go?"

Jynis squirmed. But again there was no choice. She bit her lip and nodded curtly. "You go. I'll hold the rope. Yank it when you've got him."

"Right." He hooked the rescue pack over his arm, looped the rope behind him, and stepped backwards into the void. The wind tore at him as he descended. Almost immediately, he disappeared into the blowing sand.

Jynis watched him go. She squatted by the crevice, one hand around Shani, the other on the rope. What would Cuvey do when he found Puma. The *artificial* man? The bitter dispute between Necessity and Iyusha didn't stop at family lines. She knew that well enough.

"Puma," she whispered helplessly. And then she said it louder. "Puma!"

"Jynis?" The voice in her earphones was weak; laced with pain . . . almost lost behind the static generated by blowing sand. "You here?"

"Near, Puma. What happened?"

"Lip of the gorge . . . gave away. Leg's . . . broken—femur. Hey. Hi Jynis. Didn't know you knew how . . . to rappel."

"Don't, Puma. 'S not me."

He must have realized then who it was, and tried to move. Tears started in her eyes at his scream of pain. "Puma!" she called. "Puma, answer me, please." There was only the crackle of static. "Puma, wake up, wake up! Puma!"

She started back up the slope. When she reached the truck she hit the emergency override on the lock, blowing the cabin's seal, venting the interior. Shani was crying against her chest. Jynis held her tightly, while rummaging frantically through the lockers, looking for the pistol that she kept just in case one of the oryx injured itself too badly to be treated. She found it, then dug out the ammunition and loaded, while trying to balance wailing Shani. She started for the lock.

A figure filled the opening. Cuvey. She turned the pistol on him. "Where's Puma?" she demanded. "And don't tell me he's dead!"

"He's not." Cuvey looked carefully past the weapon. "Though he does have a compound fracture. I put an air splint on it, but I'll need a stretcher to get him out. Do you have one?"

"A stretcher?" She looked at the gun in sudden confusion. Then, with a grimace, she shoved it into her pocket. She started back toward the lockers, then hesitated. "Cuvey . . . why help us?"

His dark eyes were angry as he gazed at her over the rim of his respirator. "You're family, Jynis. Why is that so hard for you to understand?"

She shrugged, shamefaced. Then she went to the lockers, where she pulled out the bag that held the disassembled stretcher.

"I'll need another rope," Cuvey

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said.

She found one for him. Some twenty minutes later, they had Puma safe aboard the truck.

(2)

Cuvey resisted sleep for as long as he could, knowing what sleep would bring. He sat up late, talking to Jynis and listening to the sandstorm hiss and howl outside the door of the underground field station. It was a big storm. Big enough to keep everyone pinned down in shelters, friend and enemy alike. Big enough to keep the radio out of commission. Or at least Jynis would believe that. He'd surreptitiously disconnected the antenna cable, just to be sure.

He jumped at the touch of Jynis's hand against his shoulder. "Lie down," she said. "It's late. You don't have to stay up to entertain me."

She'd doped up Puma. He was snoring on a pallet a few feet away in the low-ceilinged bedchamber. Once again, Cuvey found his restless gaze fixed on the boy. Puma's blond hair gleamed in the yellow light and his cheeks were rosy with fever. He lay half on his back, his chest exposed by the blanket that covered his injured leg. Cuvey stared at him, waiting for him to breathe, watching for the telltale rise and fall of his chest, unconsciously holding his own breath until his lungs burned for lack of oxygen. Puma slept on, drawing breaths in the oxygen-rich atmosphere of the cache that were so shallow the motion was undetectable.

Why had the elders said nothing about Puma . . . and all the other kids like him? Cuvey's gaze touched on Baby Shani, asleep in her mother's bed. It was inconceivable to him that the elders didn't know about this new generation. They must know. If Jynis made no secret of it, neither would Necessity. Yet the elders had never hinted at how rapidly the enemy was changing. Even his own dad, who'd sat on the governing council for as long as Cuvey could remember, had said nothing. . . .

Puma was still a boy. But he'd be a man soon. How easy would it be for a man like Puma to cross the border on foot, moving at night, independent of an air supply? He could carry explosives instead of oxygen. He could reach Iyusha within two or three days.

No wonder the elders were pressing this war *now*.

Cuvey lay back on his pallet, trying to control his own harsh breathing. His eyes were dry and heavy with fatigue. It'd been well over a day since he'd had a wink and he knew he couldn't hold off sleep much longer. Still, he didn't want to sleep. He didn't like to sleep. If only he could skip tonight and go straight to tomorrow, even though tomorrow would only bring another phase of the war.

Jynis smiled at him. "Can barely keep your eyes open," she chided. "Why fight so hard to stay awake?" By her tone, he knew she didn't really expect an answer. He watched her as she turned down the wall light until it was a faint, gold ember.

His heart fluttered in the near-darkness. He didn't want to sleep. "Do you look like our mother?" he asked im-

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pulsively.

"No." Her voice came out of the shadows. "Not at all." He could hear her lying down. He could feel his own eyes flutter shut, and then the weight of the darkness as it rolled in close around him, like a ghost that had been waiting long to take him. He gave in and let it have him, because he'd tried before and found that it was impossible to stay awake forever.

The darkness deepened. He could hear a distant wind blowing. It drew nearer, and nearer, until blowing sand stung his cheeks. Blood exploded in his rifle sights, redder than the red rocks of the Barrens. God stood beside him, an invisible presence that offered no guidance, only judgment. "*It's not fair!*" Cuvey screamed at Him. Flames ran through a tunnel, then burst outward into the night, like the sizzling tongue of a great dragon buried in the ground. Cuvey whooped in joy, half-drunk with easy triumph. He capered with Royce across the sand while the dragon tongue lit up the night, burning the empty field station at Hobo Flats. The mission was half done and they hadn't killed anybody. God was pleased. He knew it. God was pleased.

But the enemy couldn't leave it at that, couldn't let things be. *We didn't kill anyone!* Cuvey whispered fiercely.

The flames must have drawn the old man home. He'd come in from the desert, gimping and stumbling over the rocks, his respirator whistling with the force of his draught. Cuvey quiet now in the shadows. God conveniently absent.

Fa'a was up on the ridge with the truck and he took that moment to start the engine. The vehicle exploded in a geyser of flame, as if the dragon's back had been stabbed and fire had burst from the wound. Cuvey stared in disbelief at the fierce pyre that consumed his friend, his only way home. *We didn't kill anyone! Not this time.*

Then the old man chuckled, only a few feet away. "Gotcha, you bastards."

Cuvey stayed cool. This wasn't his first time. He moved in silence, a shadow within a shadow. A bad dream. The old man didn't laugh when the bullet took him through the heart. In the light of the dying fires, he appeared mildly surprised.

Cuvey stomped over to the corpse. He kicked at it, hating the elders, all of them, Iyushan and enemy alike. They were all one. They'd spent years together on the colony ship. They'd celebrated together the day they'd made landing on this god-forsaken world and they'd torched the ship together, burned their last bridge joyfully together. They were all friends. They couldn't bear to kill each other. So they begat kids and sent them out to do the killing.

Near dawn Royce found the old woman. She was holed up in a truck less than a mile from the burned-out field station. Royce was low on oh-two and he wanted that truck. Cuvey felt the same. No old woman was going to keep them from getting home.

Royce went in first. Cuvey hung back on the ridge, hunkered down

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with his rifle, keeping the old lady in his sights. He couldn't shoot through the windshield. The glass was tempered to withstand sandstorms; a bullet wouldn't pierce it and he had no explosives. She could have just stayed in there until their oh-two ran out and she'd have been perfectly safe. But she knew her old man wasn't coming back to her and she wanted Royce in trade.

She saw Royce out in the rocks. She put on her air-pack, got her rifle, and opened the lock. Cuvey had her clear in his sights. He could have killed her then, but the look in her eyes stopped him cold. Such a look of hatred he'd never seen, and it froze him. She used the moment to blow a hole in Royce's heart. Cuvey fired then, but it was too late. He was alone.

Bone and blood coated the walls of the truck's lock. The old woman's body was slumped across the floor, her skull half gone and brains looking like spoiled jelly. Cuvey blew the seal, frantic to get past the mess. Inside, the engine compartment was wide open, with engine parts spread across the floor. Cuvey gazed at the scene, feeling the weight of God there beside him. And he started to laugh. He fell to his knees and laughed, until his respirator began to honk a warning of low oh-two. Then he pulled himself together and waded through the parts, kicking and cursing at the useless collection of metal. He knew he was looking at a minimum of a day's work to put it back together. No wonder the old folks hadn't made it back to the field station last night.

He stood in the middle of the mess, wondering what to do. He could try to reassemble the engine. But more than likely something needed to be replaced. Couldn't exactly call into Necessity for spare parts. And by the end of the day, when the old folks didn't check in, somebody might think of sending a patrol out this way.

He crouched on the floor, his head down between his knees. He was almost out of oh-two and his respirator howled the emergency with every breath.

They'd been so confident when they'd set out—he and Royce and Fa'a. It was to be a lightning mission. Hit the Hobo Flats field station. Torch it. Hit the Paris Ridge field station. Torch it. Run for home in time for breakfast in the mess hall. His dad had even come to see them off. "Your sister's at Paris Ridge," he'd said, as the boys checked their equipment. "Bring her home."

Cuvey's head snapped up. *Jynis.* If only he could make it to Paris Ridge, he would find Jynis. She'd been stolen away from home even before she was born, but Cuvey still felt as if he knew her. In his dreams he'd come for her a hundred times, to rescue her from the enemy. In his dreams, she was just like him.

He ransacked the truck, looking for extra air-packs. But the old bitch had drained them. So he stripped the pack off her back. Then he set out for Paris Ridge. By the time he ran out of oh-two, the wind had scoured the blood from his hands.

The wind was still howling when

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he finally awoke. He opened his eyes to near darkness. Baby Shani was standing next to his pallet, staring at him. He smiled at her. It was hard to think of this little girl as the enemy. She didn't look like a freak. He wondered if Dad would say kill her anyway. His smile faded, and Shani toddled off toward her mother's bed. Suppressing a groan, Cuvey raised his head and looked around.

Jynis and Puma were still asleep. In the windowless shelter he couldn't tell if it was night or day, but he had no desire to encounter more dreams. So he kicked off his thin blanket, shrugged on his shirt, and headed for the kitchen to brew a pot of tea. Baby Shani joined him a minute later. He coaxed her onto his lap where she explored the stubble on his cheeks with a child's curious hand. He'd been surprised to discover he had a niece. Children always surprised him with their own reality, with their instinctive refusal to fit within the confines of a strategic equation that would classify them as unripe ammunition for the war.

He tickled Shani, and she laughed. What to do with her? The war wasn't over. He still had to burn this shelter. And Dad hadn't said anything about bringing an altered grandchild back to Iyusha.

His gaze shifted from the child to the parka Jynis had worn yesterday. She'd left it draped on the back of a chair. As he looked at it, an icy feeling stole across his belly. He felt fairly sure that the gun Jynis had turned on him yesterday was still there in the pocket of the parka. He wanted to forget it was there. He hated this war. But God was watching.

Carrying Shani in the crook of his arm, he stood up and walked around the table. He patted the parka until he found the weapon, then he dropped it in a deep pocket of his pants. The tea was ready. He poured himself a cup.

(3)

Jynis slept late. Shani was already gone from the bed by the time she woke up. "Shani?" she called, lifting her head. Puma was still asleep, but Cuvey's pallet was empty.

She was on her feet in an instant, stumbling out of the bedchamber and into the kitchen. Cuvey looked up at her as she came in. He was stretched out on the cold floor, a steaming cup of tea at his elbow while he watched Shani play with the touch pad of Puma's sturdy pocket computer. The little pc's had lately become favorite toys.

"Good morning," Cuvey said, greeting Jynis with a gentle smile. "It is morning, isn't it?"

Jynis shoved her hair out of her face; her heart still pounded from the flash of adrenaline. "More or less," she growled, unaccountably angry. She listened to the wind. It didn't sound as fierce as it had last night. Maybe the storm was easing. Maybe Cuvey could go home today after all. She hoped so.

"Get you some tea?" Cuvey asked.

"In a minute. I need to check on Puma." She returned to the bedchamber, running her fingers self-consciously through her hair, trying to straighten it. She must look awful.

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She crouched beside Puma. He was stirring in his sleep. She laid a gentle hand on his forehead. He'd been feverish when they'd brought him in yesterday, but after a night's sleep he'd cooled down some. She spoke his name softly. His eyes fluttered, then focused on her. He hardly seemed to breathe, so saturated was his system with oxygen in the rich atmosphere of the shelter. In these circumstances, his body accepted a high CO_2 level to keep him from becoming giddy. "Hey," he muttered. "We still alive?"

"Sure." She smiled, and stroked his cheek. "You scared me bad."

"That Iyushan scared *me*. Saw him in the dust; thought I was dead. How'd I get away?"

"Don't remember?" she asked curiously.

"No."

"He hauled you out."

Puma gave her a quizzical look. "Why?"

"'Cause he's my brother, Puma. Out of Iyusha."

Puma's jaw worked as he struggled with that. Finally: "He tell you that?"

She scowled. "*You* said he looks familiar. Who does he look like?"

Puma just gazed at her, his eyes sullen. "Where is he?"

"In the kitchen, playing with Shani."

"You left him alone with her!" He started to get up, but Jynis pushed him back down on the pallet. She tangled her fingers in his pretty blond hair and gave it a good, hard pull. "Not hearin' me, Puma!" she hissed at him. "Cuvey's my brother. Not here to hurt us. Not here at all, officially. 'N you're not gonna breathe one word of this to Necessity." She yanked on his hair. "Got it?"

He yelped and slapped at her hand. She let him go. "You're crazy, Jynis," he said. "He's gonna kill you."

"Didn't kill *you*," she growled. "That tell you somethin'?"

She helped Puma to the toilet, then brought him breakfast. When she returned to the kitchen the pc was still on the floor, but Cuvey and Shani had disappeared. She found them in the air room, just inside the lock. The electrolysis plant was housed there, and the tanks of hydrogen and oxygen. Cuvey held Shani in the crook of his arms. Together, they admired the hawk on its perch near the door. "Don't let her close," Jynis warned. "Hawk's mean." Cuvey stepped back a pace, while the bird preened restlessly.

Jynis glanced at the windspeed meter. It showed barely fifty miles an hour. She pulled on a thick, gauntleted glove, then freed the hawk from its perch. "Weather's calming down," she said to Cuvey. "We need to go."

"I'll check out the respirators."

"Good." She set the hawk down on the floor of the lock, then stepped back and closed the door. Pumps began draining the excess air. "Come on, Shani," she called. "Time to dress." Cuvey passed the baby to her, though he seemed reluctant to give her up.

"She breathes shallow and slow," he said.

"Yeah."

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"But she doesn't seem . . . *wrong*."

Jynis gave him a scathing glance and started to turn away. She was surprised by his hand, hard on her shoulder.

"It's not my word, Jynis. It's what they say in Iyusha. Shani's a beautiful child." The tension in his eyes startled her. "How deep is the change?" he asked.

"Huh?"

"Is it heritable?"

She gazed at him for a long moment, trying to decipher his intentions. "Why, Cuvey? You're thinking what?"

He blinked, and suddenly his expression grew hard. "Just curious." He reached for the respirators, and started to strip and clean them. "How soon can you get ready? I have to get back before my officer finds I'm AWOL."

"Twenty minutes?"

"Good."

She stopped by the radio to check in with Necessity. But the unit only pulled in static. The antenna must be down. She cursed softly. If Necessity didn't make contact with her today, they'd steer a border patrol this way. She and Cuvey would have to hurry.

She moved quickly, changing Shani, giving her a bite to eat, getting herself dressed. Puma watched her sullenly. "He's gotta be a criminal," Puma said. "How can you just let him go?"

She pulled on a fresh shirt and stomped into her boots. "He's my brother. How can I let him hang?"

"Everybody's got family on the other side."

"Cuvey's not on the other side," she pointed out. "He's here."

But Puma persisted. "You were ready to kill him yesterday."

"Didn't know who he was."

"Still don't. Maybe he *did* kill Greg. Ask him?"

"Shove off."

"At least leave Shani here."

She gazed at him thoughtfully, then nodded. Cuvey's interest in the child unsettled her. Better to leave her here with Puma. "OK."

"*Jynis!*" Cuvey shouted from the other side of the shelter. "You ready?"

"Three minutes!" she called. She went to the kitchen; picked up Puma's pocket computer from the floor and set it on the table. Then she retrieved her equipment belt and strapped it on. Her own pc was still in the holster. It pressed against her thigh. She tapped absently at its housing. Puma's doubt was working on her nerves. She went over again in her mind what she was doing, but the conclusion came out the same. She just couldn't let Cuvey hang.

"Jynis," Puma called softly. She went back to the bedchamber and looked in. Shani was playing on the floor with her blocks. Puma was frowning thoughtfully. "Did you ever contact Hobo Flats?"

"No. Radio's down."

"Try the hawk?"

"Later, Puma. Gotta go."

"Then get me my pc and I'll do it!"

She scowled at him in irritation. She didn't want Puma making trouble. "No," she said. "You rest. I'll take care of it." She slipped her own computer out of its holster and opened

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it, then leaned in the doorway and tapped in a string of commands. The hawk had flown north. She called it around to the east, guiding it toward Hobo Flats. Suddenly Cuvey was at her shoulder. She jumped, startled by his silent approach. Soldier quiet. He already had his air-pack on. His respirator dangled around his neck.

"What are you doing?" he asked.

"Lookin' around. Couldn't raise Hobo Flats yesterday. Maybe some trouble there."

"Looking around?" Cuvey gazed over her shoulder at the computer display, then frowned darkly. "That picture's not real time."

"Sure is," Jynis told him. "It's out of the hawk. Iyusha doesn't do this?"

Outside, the air was still thick with dust suspended by the storm. Visibility wasn't good. But through the haze she thought she saw a truck stalled in the Barrens. *Stop hawk!* she thought, and tapped in the command. *Turn about and circle that.*

The hawk's vision was very good. As it flew lower, she could see the truck's open lock. She could see the swollen body sprawled across the floor there, chest up, mouth open. But the head was half gone. She felt Cuvey move away from her side, and her gaze turned to follow him. Their eyes met, and she saw the truth in his cold stare. "*You bastard!*" she hissed.

Suddenly her pistol appeared in his hand. He stepped back into the kitchen, grabbed her parka from the back of a chair and held it out to her. "Put this on," he said. "We're leaving."

She stared at the gun as if it were a willful thing. She told herself he would never hurt her. Told herself that over and over again. "No," she answered, closing the pc and slipping it back into the holster. "Go alone. Murderer."

"Put it on!" Cuvey shouted. "You don't belong with these freaks. You're coming home with me."

"No."

He snarled at her. But to her surprise, he lowered the gun. "Fine then, little sister. Stay."

He dropped the parka on the table, then turned and strode toward the front of the shelter. Jynis glanced quickly at Puma. He was huddled in a corner of the bedchamber, Shani sheltered behind him. "Get dressed," she growled at him. Then she turned, grabbed a knife from the kitchen, and ran cautiously after Cuvey.

She found him in the air room. He didn't seem surprised to see her. He turned the gun on her again. "Stay back," he said. But she had no desire to approach. "This world belongs to Iyusha, not to the traitors at Necessity."

"You came here to kill us."

"Not you. There's not enough of us left. Dad wants you home."

"I am home."

Cuvey scowled darkly. His gaze left her, to scan the pressure gauges on the air room wall. "Your hydrogen tanks are full. Ah, oxygen too." Reaching out, he turned the couplings, one for each tank. The hiss-roar of escaping gases filled the room.

"What are you doing?" Jynis yelped. She leaped for the panel. "That's hydrogen. One spark and—"

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Cuvey knocked the knife from her hand in one practiced blow. "*Boom*," he whispered, as she scrambled back out of reach. "Now get in the lock."

"But Shani! 'N Puma—"

"Get your little baby if you like. But get in the lock."

She darted back to the bedchamber and went to her knees beside Puma. He'd dressed Shani in her thermal suit, and was struggling into his own parka. "Hurry up! Hurry up!" she screamed at him. "He's going to blow the shelter!" She helped him with the parka, then hauled him to his feet. He grunted with pain; his face went pale. She looped his arm around her shoulders. "Try to walk." Shani was clinging to her leg, howling to be picked up. Jynis reached a hand down to her.

Suddenly Cuvey was there. He snatched up the child and strode wordlessly forward. "Come on, Puma," Jynis pleaded. As she went through the kitchen, she grabbed her own parka. Puma's face was beaded with sweat. "Come on," she told him. "We can make it."

They reached the air room. The pressurized tanks were still dumping their mix into the atmosphere of the shelter. Cuvey was waiting in the lock, wearing his respirator. He held Shani with one arm, the pistol with the other. The welding torch stuck out of the pocket of his parka and Jynis's air-pack was at his feet. He shoved the pistol in Puma's face as Jynis crowded him into the lock. She slapped the button to cycle the lock, and the door closed. "This is why you came here, isn't it?" Jynis shouted at him over the sound of the pumps. She wanted to grab her air pack, but she'd have to drop Puma to do it.

Cuvey leaned forward, pressing the muzzle of the gun against Puma's cheek. "We had a team on every field station between here and Necessity. I could have been on any one of them. But I came to Paris Ridge for you. I'm gonna bring you home."

The outer door opened. Jynis's ears popped at the pressure change. She drew in a lungful of thin native air and held onto Puma.

Cuvey put Shani down, then took out the welding torch. "Out," he said quietly.

Jynis grabbed Shani's hand, then nudged Puma. "Let's go."

He leaned on her lightly, trying to take most of his own weight. After ten steps she was breathing like a runner at the end of a race. She stopped and looked back. Cuvey had the torch lit. He leaned down and placed it carefully on the floor of the lock next to her air-pack, then he stood back as the door began to close.

"*My pack!*" Jynis whispered.

"Never mind!" Puma cried. "Gotta' get out of here!"

They had twenty seconds before the lock's inner door opened and the torch ignited the cloud of hydrogen gas. Counting the time, Jynis staggered across the sage flats, hauling Shani with one hand, supporting Puma with the other. At twelve seconds Cuvey caught them. He grabbed Shani. Jynis blacked out.

She opened her eyes to see the hawk circling far overhead—dark wings against a rusty sky. Puma lay beside her, eyes closed, breath drawn

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in ragged gasps. He sweated pain. She sat up slowly, listening to the low roar of flash fire, sensing it in the ground. Even that effort required oxygen; she started breathing fast and deep—impoverished air bearing the scent of sage. She started when she saw Cuvey.

He stood not five meters away, cradling Shani in his arms and watching as the door of the shelter melted in the searing heat.

Shani was crying. Jynis struggled to open her eyes, to bring her mind up to the level on which Shani existed. It seemed a long time before she could manage it. But at last the dusky shadows that obscured her vision began to part. Shapes appeared: the tall columns that supported the bunks in the back of the truck; the rattling bank of lockers. Jynis turned over—it was all she could manage—and found Shani in the bunk beside her, her little face sticky with snot, and red from crying. The world began to spin. She grasped that she was about to black out again, so she concentrated on her breathing, drawing in huge lungfuls of air in quest of sparse oxygen molecules. Shani's face stabilized.

Cautiously, Jynis moved a hand and started to stroke the baby's cheek. Shani seemed oblivious to her efforts. The bunk bounced and rattled, the engine gunned sporadically, and with a sudden, profound inspiration, Jynis realized the truck was in motion.

She smiled. Puma was taking her home to Necessity. Good. She hadn't seen her mother in so long.

Too bad he'd forgotten to pressurize the truck. Natural mistake, of course. Low oh-two was right for him. Right for her. Helped her sleep. She just wanted to sleep. But Shani kept on crying, a grating, wailing sound that cut through the lulling noises of the truck in motion to scour at the fibers of her body.

"Shani," she whispered. "Shani, don't cry."

Puma had broken his leg. The thought popped into her head as Shani paused in her lament to gulp at a lungful of air. Puma had broken his leg.

Something about that. . . .

She groped for the elusive thought. Impossible, impossible. What? To drive the truck? With a broken leg.

Her eyes snapped wide open, and she lifted her head a spare inch. She could just make out the back of the driver's head. His hair was black, not blond, and it was bisected by the strap of a respirator. Cuvey.

Then where was Puma? She couldn't remember; couldn't seem too think at all. At least Shani was winding down. Something seemed to have caught the baby's attention. She sat up, swaying and bobbing with the motion of the truck. Then she reached out toward Jynis's hip. Jynis followed the pudgy hand with her eyes, and smiled. Shani wanted the pc in her hip holster. "Go ahead," Jynis murmured, her eyes half-closed. "You can play with it."

Shani tugged, wrestling with it until it popped out of the holster. Jynis helped her open it on the narrow space of the bunk. It was still tuned to the hawk's optic nerve. On the little

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screen she could see the rough, red rock country of the northern Barrens. A truck moved rapidly up the wind-smoothed floor of a shallow gully, trailing a high plume of dust behind it as it headed for the border. The oryx herd grazed in a little rill to the east.

Jynis felt her heart quicken as she gazed at the antelope. They were overdue for their supplementary feeding. She should have cared for them yesterday, but the storm had forced her inside. She could call them now. They'd come running to the sound of the truck. They'd mob the vehicle. Cuvey would have to slow his headlong rush back to Iyusha.

She thought for a moment, then carefully entered a code that would stimulate in the oryxes a craving for the minerals in their supplementary feed.

(4)

Cuvey drove the truck as fast as he dared. He could feel the press of time like a poison in his blood. The coordinated attack on the line of field stations was over a day old. If not for the storm, this part of the desert would already be crawling with enemy patrols. Now that the storm was past, he had at most a few hours to get away. He skidded the truck around a bend, then gunned the engine, racing down the wind-smoothed floor of the shallow gully, heading for the border.

Suddenly a fleet of white beasts leaped in front of the truck, followed instantly by another, and another, and another. He screamed in surprise, and hauled hard on the steering stick. There was a sickening thump, and then the truck caromed across the gully floor, climbing the narrow embankment for a few meters before slamming into the vertical wall. He jerked and pulled on the steering stick, but the truck had already begun to topple. It slammed over onto the ground and skidded on its side before coming to a stop.

Cuvey found himself hanging from his safety harness. Blood and bits of white hide smeared the outside of the window. Farther down the gully a herd of white, shaggy, horned antelope milled beside the steep walls.

He felt a fire ignite in his belly, a growing pressure that threatened to choke him and suddenly he was screaming in pure rage. He snapped out of his safety straps and kicked at the console, cursing the truck and the antelope and this barren world that had never offered anything that, in the end, had not proved to be a poison to his soul.

Even Shani. As an Iyushan, he was supposed to hate her. He'd tried to hate her. He knew she was *wrong*. But she was part of him. A beautiful child. And he knew, deep inside, with a fatalistic certainty, that he would never live long enough to see another child born in his family.

The baby's cries sliced into his rage, dividing and draining it. "Shani?" he called, suddenly frantic. "Jynis?" He climbed out of his seat and clambered through the overturned truck.

He found Shani in the space between the two bunks. She had a red, swelling bump on her forehead, but

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she cried lustily and stood up to reach out to him. Shani. He grabbed her and held her tight, astonished by the warmth of her cheek against his neck. He kissed her hair, knowing he should have left her with Puma, back at the burned out station. But he couldn't bear to leave her. Oh God, he was so tired of this war.

"*Mama-ma-ma-ma*," Shani was crying.

"Where's your mama?" Cuvey whispered. He looked past Shani. His gaze found Jynis. Her body was draped over one of the bunk's support columns. She wasn't moving. Cuvey went to her. He set Shani carefully down against the overturned bunk, then bent over Jynis. Her breathing was as shallow as a whisper. Her lips were turning blue.

He ducked his head and yanked the respirator off his face, then slapped it over her nose and mouth and pressed the demand button, forcing air at her. "*Breathe!*" he hissed in her ear. "*Breathe, Jynis.*"

He'd kept Jynis on native air too long. The truck's tanks were empty. He didn't have another air pack. He'd thought it would be all right, but he'd let it go on too long. Everything came back to poison his soul. "*Breathe!*"

Her chest rose slightly. Her eyes fluttered. Then she drew a deeper breath. "Shani?" she whispered.

"She's all right," Cuvey said, around an intense pain deep in his throat. He took the respirator back and drew a couple of breaths, then returned it to Jynis. She finally opened her eyes and looked at him. He couldn't read her expression. "The truck's wrecked," he told her. "We're going to have to walk. It'll only take a few hours."

She passed the mask back to him. "You torched my air-pack."

He didn't want to talk about that. He'd thought things might go easier if he could keep Jynis dependent on him. "Don't worry," he said. "We can buddy-breathe, and get there on one pack. It won't be easy, but we can get close enough to the border for a patrol to come over and pick us up."

"Uh-uh. I'm not going with you."

"You have to. This is the only air-pack."

"No thanks. I'll pressurize the truck, and wait for my people to come."

"The truck's tanks are empty."

She glared at him like he was a foul, deformed creature from the fields of hell. "You're a liar."

"No. See for yourself. The tanks bled dry after you blew the lock." He helped her move forward and she found that it was true. There was no air left on the truck except what was in Cuvey's pack.

"Let's go," Cuvey said. "Every breath we take here is wasted." He passed the respirator back to her, but she'd already turned away. She was making her way back towards the bunks, breathing hard. She stumbled, and almost went down. "Jynis!"

He caught up with her and slapped the respirator over her face. She breathed deeply, gratefully, leaning against his arm. "Have to—find the pc," she gasped.

They found it against the bottom of a bunk. It still worked. Cuvey studied the picture a moment, then decided

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the hawk had gone east. On screen, he could make out a plume of dust near Hobo Flats. Fear prickled across his skin, leaving a thin film of sweat.

"They're coming," Jynis said.

Cuvey shook his head. "They might not get here for three or four hours! You won't last that long on native air."

Shani had crawled into her mother's lap. Jynis stroked the baby's hair. She said nothing, but tears started in her eyes.

"Jynis!" he screamed at her.

"You started it!" she snapped back. "It's not my fault. It's 'cause *we're* wrong. You 'n me 'n all the elders. We're wrong for this world. Don't belong here. We're too fragile. But Shani will still be here when they come. And Puma. And Puma...." She looked up at him, her eyes wide with fear. "*What did you do with Puma?* Did you murder him too?"

Cuvey denied it with a shake of his head. "No. I just left him. *He'll* be all right. Not like you and me."

He sat back, leaving the respirator with Jynis. He felt taken by a great wave of weakness that seemed to roll down out of the sky. It coiled like a noose around his neck, choking him. He saw himself swinging from the gallows at Necessity. A cry burbled up from his throat, but he bit if off before it could emerge. He reached for the respirator and breathed deeply, then passed it back to Jynis. He could strangle in this atmosphere just the same as in a noose. It was all the same. Because Jynis was right. They weren't made for this world.

He chuckled softly, self-deprecatingly. "All my life I've dreamed of you, Jynis. I wanted to be your hero, the one who brought you home."

She'd been engrossed with the pc, tapping in commands to the hawk, but now she looked up at him, her eyes narrowed combatively. "I won't go with you."

He nodded, remembering the terrible blue color of her lips. A few minutes more without supplementary oxygen, and she might have died. Her image shifted in his mind. Her blue countenance became a metaphor for Iyusha: an oxygen-starved body politic slowly suffocating on a hostile world. "Resuscitation unlikely," he muttered. A cold sweat broke out across his cheeks. A few minutes ago he'd been determined to bring Jynis back to Iyusha. Now he had to wonder: why? To watch her die with the failing colony?

He shook his head. "It's all gone wrong," he said, half to himself. "Iyusha's finished. We're going to lose this war. The land and the air are our enemies, and we are bound to lose." He looked up. "Jynis—I was wrong to try to take you. I know it's too late, but... *I'm sorry.*"

She looked away, one hand swiping quickly at her eyes. "Let it go," she said. "We understand each other now."

He nodded, conceding that.

When she looked back at him, there was an odd gleam in her eyes. "Know if the truck's radio still works?"

He shrugged. "Why?"

She tipped the pc's screen toward him. "Look. Iyushan patrol less than

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twenty miles to the north. Call them. Tell them to come get you."

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Jynis didn't understand why she was doing this. Cuvey was a murderer. He'd killed the staff at Hobo Flats, she had no doubt of that. Their deaths were his fault, his responsibility. He was an enemy soldier, and if he weren't her brother, he would have killed her too. "Call them," she repeated.

He responded with a resentful gaze. "I won't do it. They'll get here before your people. They'll take you and Shani back to Iyusha. I can't let that happen now."

"Don't tell them we're here. Walk out a couple miles. Meet them."

"And leave you on native air."

"Done it before. Lasted over an hour." She touched his cheek. "Be picked up in time. Don't worry. Now call them. Please. *Don't* want to see you hang."

He looked at her doubtfully. She nodded encouragement. And finally, he reached for the radio with a trembling hand.

He stayed as long as he could. But as both patrols drew near, they knew it was time for him to go. "This war's over for me," he told her. "I'm tired of serving the elders. I won't do their killing for them again."

She nodded and hugged him. Peace was a distant thought, a dream that had soaked into the sand, to disappear with the blood of sundered families. She took one last pull from the respirator, then let him go, feeling oddly triumphant, as if she'd won something precious this day. She grinned at him and waved good-bye.

But as she watched him jog up the gully, she knew she was making too much of it. The war wasn't over. Cuvey was alive now, but he could be dead tomorrow by a sniper's bullet. And she was so exhausted, she knew there was a real possibility she wouldn't survive until her rescue. Yet . . . she had gained *something*. A moment outside the war. A chance to act on her own conscience, from her own heart. Duty and history be damned. It was a giddy feeling. A giddy feeling. . . .

She sighed as her thoughts began to dissolve in the dearth of oxygen. She cradled Shani on her chest, dreaming of life, of change. She would let herself sleep now. But as her eyes fluttered shut . . . she swore to this world that she *would* wake up . . . again. ■

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THE ALTERNATE VIEW G. Harry Stine

CITIES, FOOD, AND WAR

Several of these columns have discussed various aspects of cities. This is because cities cannot exist without technology. And without cities, civilization wouldn't exist. Cities are responsible for civilization because, by definition, civilization is the art of living together in cities. Perhaps this is circular reasoning. However, when we get right down to basic definitions, things are often defined in terms of one another.

Some historians believe that cities exist because of trade. This may be only partly true. I'd like to offer an alternate view: cities exist because some people developed a system of control of resources as a means to control other people. Over the millennia, it's developed, changed slightly, and become very complex. When it began for what may be simpler reasons, it included the need to wage war. And all of this depends upon food.

This view that warfare might have been necessary may be repugnant to many readers. Believe me, I detest war. I'm a techno-capitalistic humanist to whom war appears to be a waste of time, energy, effort, materials, and human life. But what war appears to be and what it is could be different.

The world is still full of people who think the same way as their ancestors did 10,000 years ago. But the world is now evolving into a place where it's easier to make it than take it, to trade rather than raid. In the twentieth century the trader and craftsman, detested by the rulers of the past, have evolved into powerful business people who are calling the shots in a world of growing abundance. The businessman wants to engage in trade. But until the majority of people in the world shed the old ways of thinking and move into the new millennium, the commercial act of trading will continue to be interlinked with cities, food, and war.

In any event, any activity such as war in which humans engage to the extent they do, that has such a profound effect on human lives, and that is resorted to repeatedly with what may be passionate but spurious reasons, certainly deserves study and attention.

War is an expression of a desire to use coercive physical force to control

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resources and thus the ability to parcel out these resources to people who will do what you want them to do. War is an extension of power over people by other people through the use of resource control. Resources include food. In fact, after water, food is the most important resource.

Have we seen any warfare recently that involved resource control? (That question is rhetorical; the answer is too obvious!)

How could this have started? Why are cities and food important factors in the equation?

It began when some people accumulated wealth and other people decided it was easier to take it than make it. Nomadic herdsmen stole animals to get food because of a bad season or bad planning on their part. Then some people in arable, fertile lands, namely the lower end of the Mesopotamian valley later called Sumer and Akkad, initiated the agricultural revolution. When they stored their surplus, they had food during the bad years. To improve and increase land use, they began communal engineering projects such as irrigation systems. For defense against marauding nomads who swept down out of the hills, they began to cluster together in villages.

Some village families controlled more and better land than others. As a result, they accumulated more resources such as food. By 3000 B.C., distinctions in relative wealth appeared. These were more powerful than the distinctions in muscular strength and aggressive behavior that defined power in other cultures.

Power in this sense is defined as the ability to direct other people and control their access to goods and services.

The villages grew slowly into cities. These early cities would be classified as "small towns" today because their population was only about 20,000 people. In these cities, control of behavior was mandatory. This control fell naturally into the hands of people who were the descendants of the old wealthy families. They became nobles, kings, and members of the priesthood. They maintained another group of people, the bureaucrats, who provided the manpower that supported the system. Economic power and social status evolved into political (social) control.

The hallmark of these early governments is the same as it is today: The ability to mobilize manpower for specific purposes such as building canals, temples, city defenses, and other "public works." Or harvesting the crops from "public" lands. Or engaging in warfare.

Food lies at the heart of this system. Part of the food production of each farmer was confiscated by the leaders and used to feed other people who had been mobilized for public works, harvesting, or the army. Bureaucracies grew as a result. In some Mesopotamian and Egyptian cities, all the laboring people received all their food from central stores. The farmers received the benefits of the city laborers in the form of canal maintenance, religious agricultural forecasts, and defense.

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Early trading between villages and cities occurred only sporadically when someone swapped surplus items from one village for surplus goods in another. This worked only when one village produced things that another didn't. In the dawn of civilization, this was rare. The only thing that one social group might have that another one didn't was some specific natural resource such as copper, tin, or stone.

But it was a world of scarcity then. There wasn't enough of anything to go around. In the best of times, everyone might have a little bit of everything, but no one had very much of anything except those who controlled resources. (We're just beginning to see the end of that epoch, but we're having a lot of trouble learning how to live in and cope with a world where science and technology are creating abundance.)

Although traders traded, they couldn't do enough of it and the results were insignificant in a world of scarcity. Therefore, the rise of the early city-states required that political leaders command powerful armies. Tribal leaders had exercised their power over people by brute force, leading loosely organized groups of warriors who were often called to service only when the leader wanted them. But as a result of the agricultural revolution, armies became bureaucratized instruments of state policy. The early empires of Sumer, Akkad, and Egypt depended upon these professional armies.

Keeping a standing army supplied was and still is a major problem for leaders, politicians, and generals. In Mesopotamia and Egypt, they solved this in a pragmatic manner using the same principles that allowed them to create such armies in the first place. They intensified central control of resources. Thus, acquiring food and raw materials such as metals became essential to maintaining political power.

In the twenty-eighth century B.C. when King Enmebaraggesi of Kish in the ancient land of Sumer wanted more food, copper, stone, or other scarce commodity, he marched his professional army into a neighboring state and took it. This was the nature of war then. If you've been following events during the last few years, this is still the way it works in most parts of the world, including lower Mesopotamia.

This whole process had a great system of positive feedback. Leaders provided the armies with supplies. With these armed forces, they obtained further resources. This wealth could be in the form of greater amounts of food, natural resources, or slave labor. The generals, officers, and soldiers were rewarded by giving them the best of the loot and more of the captured resources than were parceled out to the general populace. Serving in the army was a way to be well-fed in comparison to civilians. (Those who serve or have served in modern armed forces may find this hard to believe.) This large army gave leaders more power because military force could be used to obtain more resources for building monuments, maintaining a bigger army, and exer-

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cising more control over people.

Without armies and warfare in a world of scarcity, the early city-states could not have existed. And without reliable food supplies, monarchs could not have maintained their armies or social control over people.

So successful was this system and so difficult was the problem of military logistics that some cities were established with specific military purposes. They were fortified supply depots. Any field army in any age requires a long, vulnerable, and expensive logistical "tail" to keep the troops supplied with expendables. Food is the most important of these, especially when the army marches through territory where it isn't possible for the troops to live off the land.

Sargon of Akkad, ruler of the first region-wide Mesopotamian empire in the twenty-fourth century B.C., had city fortresses built in the outlying regions of this empire. These were staffed with royal servants and troops. They were storehouses of food and other supplies for Sargon's army when it marched through to loot scarce resources from a neighbor.

After a millennium or so when the world became richer and trade could provide an exchange of varied resources, these Sargonian city fortresses became centers for the control of trade routes. That's why most European cities were established where they now exist. In fact, many American cities began as military outposts that served as logistical centers and military control bases at critical points on trade routes. How many American cities have names that begin with the word "fort?"

Remember: Control of access to resources is the key to control over people. This includes controlling the movement of resources known as trade. As we've seen, it grew from the desire and need to control people in cities and was based upon coercive physical force.

In today's world, it's no different. New words and concepts have been coined to describe and legitimize ancient power policies: tariffs, taxes, "economic democracy," and the latest buzzword, "managed competition."

Why is it important to take these alternate views and to talk about how and why things began? Because you can't figure out where you're going and how to get there unless you know where you've been and how you got to where you are. In the past two centuries, science and technology have given us enormous power over the Universe and over ourselves. Some people are using this to change a world of scarcity into a world of abundance. Others are trying to use it to perpetuate, in modern forms, an ancient system dependent upon a world of scarcity to ensure their power over people, not increased personal freedom.

You'd better choose sides, because you're helping make the future or you wouldn't be reading this. ■

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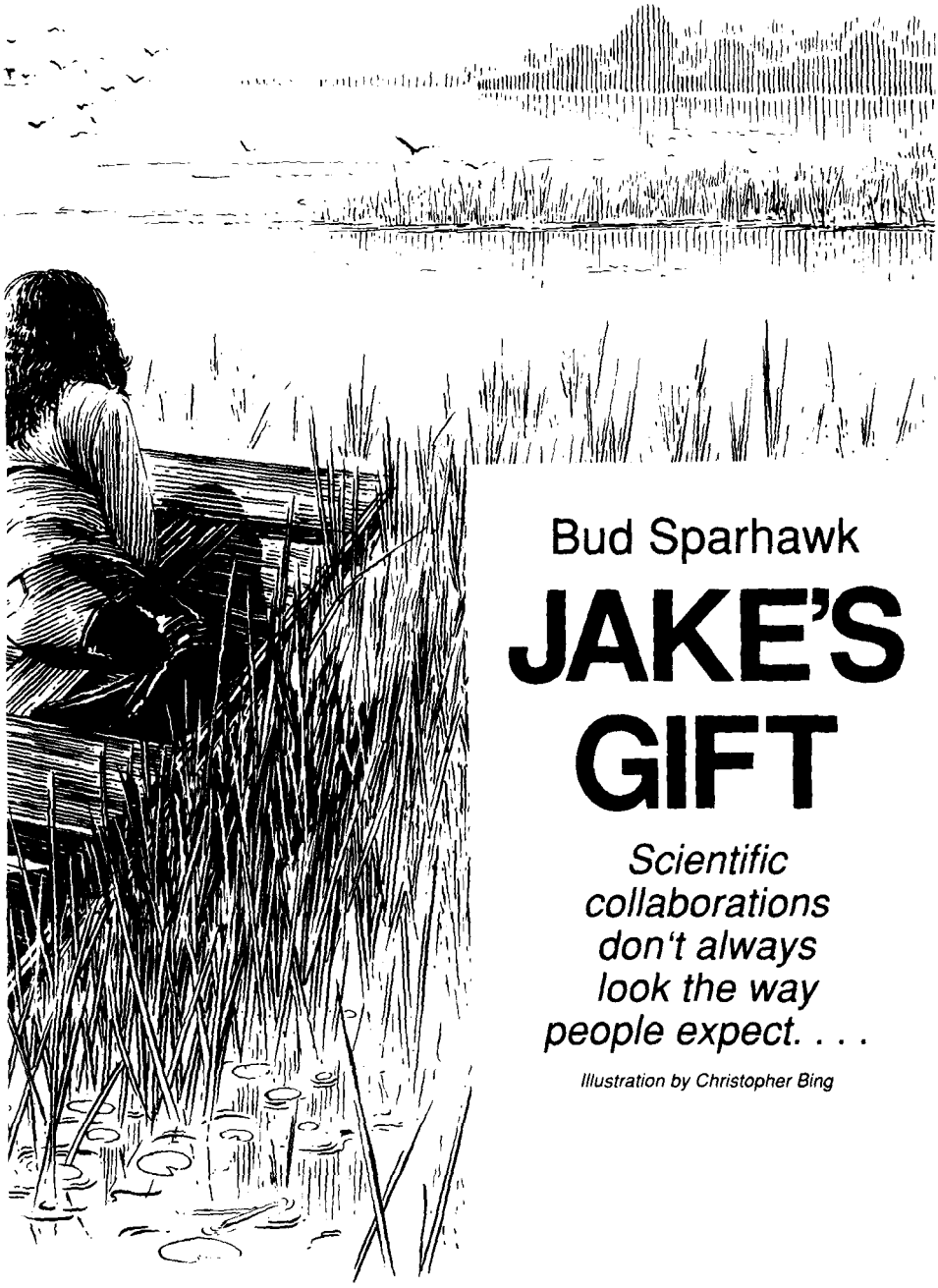

Bud Sparhawk

JAKE'S GIFT

Scientific collaborations don't always look the way people expect. . . .

Illustration by Christopher Bing

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The crisp fall wind blew the tops of the pampas grass to and fro, scattering the seed that hung heavy in their tassels. This late in the year every stand of grass was adorned with their pink plumes, ringing the marsh and hiding the brackish black waters of the enclosed pond from the nearby creek. Between the grasses and the water were cattails, displaying their own abundance of seed like fat brown sausages on a skewer. Nestled among both were the other flora of the Bay, eel grass, sonnet weed, and a broad expanse of reed, all tough grasses that could survive in the porous sand and resist the incursions of brackish water that bathed their feet at high tide.

Jake's shack was built on the edge of a small feeder stream between the pond at the center of the marsh and the beginnings of the black organic muck that was the marsh floor, which was home for the endless variety of frogs and turtles, and breeding ground to the twenty varieties of fish that inhabited the greater Bay beyond the creek. The shack was nondescript, typical of many that sprouted up around the Chesapeake Bay, its siding turned a uniform gray by the combination of sun and weather. It stood on an assortment of crazily tilted stilts that lifted the shack's floor above the high tide. Over the years Jake had had to add more supports to prevent subsidence; even buried ten feet into the bottom the poles still did not touch solid ground. Jake liked to imagine that the black goo beneath him went all the way to the bottom of the world.

A rambling walkway ran from the one and only door atop a series of floating fifty-five gallon drums to a small side extension where Jake docked his big boat and, in the other direction, marched on poles and patches of solid ground to the rutted road that led from the main road to the edge of the marsh. The walkway was a motley assortment of driftwood planks, rough cut to size and attached to the stringers with whatever fasteners Jake found at hand; wire, nails, screws, and even worn manila rope dotted the rail-less walk. Gaps over a foot wide showed in places, since the boards were set to the length of his stride. It was a daily labor to replace those pieces that both weather and tides carried away. Many was the night when he'd stumbled, trying to step on a missing board.

Close by the shack were his collection of small boats, for the most part flotsam brought to his little world by the storms and misfortune of others; damaged rowboats with broken thwarts, canoes with stove ribs and the like. Where and how he could, he returned them to their owners, the rest he repaired with whatever odds and ends were at hand and added them to his own little fleet. *Mariah*, the small blackened rowboat whose sides were so badly burned that he simply cut them away, leaving a scant six inches of freeboard above the gently curving bottom. One decent wave would swamp her, so she was useless for any work outside the marsh. On the other hand her shallow draft and light weight made her a responsive and agile vessel for his quiet forays around the marsh. *Mariah*

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could glide along with no more than three inches of water beneath her hull, propelled by Jake near the stern, push pole in hand.

The other boats he'd named *Simplicity*, *Handsome*, and *Gull*, who was a wesort rigged rowboat that he used as a day sailer. He had gotten the used sails from a loft across the Bay, near Annapolis, and had fashioned the mast himself. Her lines were odds and ends of manila and poly and cotton, depending on their use. *Simplicity* was the runabout he used to get some fresh fish for his own table, and it had a nice little three-horse outboard fastened to her stern. *Handsome* was a green sponsoned canoe with rich birch ribs and three layers of canvas overlaid with a slathering of fiberglass. He'd gone the length of the creek and up and down the Bay looking for its owner after the hurricane had blown her into his refuge, but to no avail. Now he used her for his commute to the docks on the far side of the creek when he needed an occasional job helping the crabbers in the summer or oyster tongers in the winter. It was a way of making enough to buy his few necessities.

He met Mary on a crisp fall morning when there was a gentle breeze blowing out of the southeast. Chessie, his dark brown part-bay retriever had awakened him from a sound sleep with a slobbery lick of her huge tongue. Jake kicked off the covers and scattered the assortment of cats that had chosen to share the warmth of his bed from the frosty night before. Throughout the summer they stayed on his big boat, probably thinking that they owned the smelly tub, but more likely trying to figure out with their tiny cat brains where all the fish were that made the boat smell so good. Since the boat was over thirty years old, and a fisher for the last twenty, it was no wonder that it had absorbed a certain atmosphere. "OK, OK, girl. I know it's time to get up," he groused and scratched his head, part of the morning ritual—just as throwing the door open to air out the place and release Chessie and the cats into the marsh, heating coffee on the small propane stove, fixing a small breakfast for himself, and taking a frigid dippy bath with a small bowl and washcloth were a never changing routine.

He took his coffee out the front door and gazed over the marsh. Pretty soon the ducks would be flying down from the north, and a little later the Canadian geese would follow. The flocks loved the marsh where there was protected cover and lots of food, bottom grasses, tasty frogs, and minnows. Chessie would be crazy for weeks when they started arriving, but she was too old for hunting, too old and too fat. But then, aren't we all, he thought and patted the small pot that spilled over the tops of his jeans.

"Now where could that damn dog have gone?" he mused. Usually Chessie made a mad dash down the walkway, jumped onto the sand spit, raced along the stream to the edge of the creek, turned left to chase waves for a while, and then followed the rutted path that passed for a road back to the walkway. It usually took her about a half hour to make her circuit, until

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this morning, that is. He sipped on the hot coffee and waited a while longer, planning his day.

He needed to get over to the store for some more ice, some fruit and vegetables to stock up for the next week. Then he could see what he had snagged on the trot line he'd put out the previous evening. Maybe he'd have a nice Rock or yellow Perch for dinner, if luck was with him. Otherwise it was fried whatever and crab soup. Chessie's barking roused him from his reverie. It sounded like it was coming from the far side, opposite the road. Sounded like she'd caught a muskrat, or maybe treed a 'coon. Well, he'd better go rescue the poor thing. He stepped onto *Mariah*, picked up the pole, and shoved off across the pond.

Chessie's barks sounded more distressed as the boat slid into the high marsh grasses and along a small channel carved by the freshwater spring farther up, near the tree line. The boat moved quickly along the channel since the meander was slight and the curves adequate for the length of the boat. Soon he was within sight of the dog, who was standing on a huge driftwood shoring beam that had wedged itself into the marsh during some unknown storm years past, before his time even. As soon as he came into sight Chessie stopped barking and plunged forward, tail wagging furiously. Just like that damn dog, Jake thought, expecting her backup human to pull her out if it was more than she could handle. He moved to the stern to raise the bow and gave one final push of the pole to ground *Mariah*. Carefully placing the pole on the deck he stepped onto the beam and peered into the break in the grass where Chessie had disappeared.

Mary Hellorin Kelly had grown up in the north end of Baltimore, in a staid businessman's home, with a mother more interested in doing good in the community than in pursuing her teaching career. As a consequence of her parents' desire for the ideal daughter, Mary had been sent to the "right" schools (where she terrorized her friends and teachers with an assortment of frogs, turtles, and insects that she collected), introduced to the "right" social circles (where she had a reputation for arranging canoe and raft trips, camping out, and skinny dipping), and had been taught all of the "right" arts and graces for a girl of her social status, age, and community (and which she totally ignored when out of sight of her mother).

For twenty years she had tried to appear to be a dutiful and obedient daughter, the pride of her parents' eyes. And when her uncle had died, leaving her with a trust fund sufficient to maintain her independence, she had had a fierce argument with the both of them. She left her father's dear alma mater, abandoned the pursuit of the Urban Studies major her mother had selected, and started over again in a biology major at the state university's main campus, living in the dormitories with a more diverse array of people than she had ever imagined existed. She loved it.

Seven years later, Masters in hand, she worked with the Smithsonian In-

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stitute at their Rhode River facility where she learned of the rich diversity of the tidal ecological niche. What the job lacked financially it more than made up for in the time and hard work demanded. Usually she was up before dawn, out in the wetlands up to her ass in mud and chill water, aswarm with bloodsucking mosquitoes, gnats, black flies, and a dozen other denizens of the ecology. The soprano peeping of the tiny frogs would give counterpoint to the bass croaking of the larger ones. Small birds usually chirped and twittered in the steel gray predawn light, when the insects would begin their strident rattles, rasping squeals, and screams. Sometimes she would hear a fish splash in its leap for one of the many insects that dared the surface of the water. Net in hand she would sweep the air, counting the population of the smaller insects who were individually predator and prey in the rich soup of life. Using the shorthand she had devised, she recorded each sector as she worked her way to the wetland's interface with the tidal river, moved two meters over and worked her way back. And that was one of the more glamorous jobs—it sure beat analyzing goose turds, which had been her first assignment.

But her real passion was the wetland flora; the grasses, flowers, shrubs, and bushes that tolerated the alternating fresh and brackish tidal waters that bathed their roots and managed to wrest nurture from the sand and clinging muck. Here was adaptation to a harsh environment in its finest form. Every season presented its own challenges, its own selection process. A pond was populated by the early arrivals, the cattails and the bottom grasses. Later, as their roots grew and the detritus of previous generations overlaid one another the water became shallower, eventually forming humps that were dry at least some of the time. The resulting marsh would later be colonized by the taller grasses, which would add their own measure of organic detritus to the layers. Finally, the bushes and shrubs would make their presence known, capturing dirt and mulch in their root structures until the marsh would become a swamp, and shortly thereafter, dry forest land.

And during all of this process the population of fauna changed continually, meeting the changing conditions, finding and exploiting new niches, and developing a rich variety of solutions to the problems that any life on the water's edge presented. It was fascinating. Few of the ponds and marshes that lined the shores ever made the complete transformation; strong storms and wind-driven tides destroyed much of the buildup, tore away much of the growth, and set the transformation back to the beginning.

Eventually her studies led her to a grant of her own: She was to determine the degree to which trace metals were filtered from the water by various species of wetland plants. This was an outgrowth of her mentor Jim Shepherd's studies on the effectiveness of the Bay's indigenous life in filtering pollutants, such as the rich, algae-feeding phosphates, from the water.

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Jim's studies were critical to understanding how the tidal wetlands in the Chesapeake Bay could be managed to keep it alive and productive. Phosphates entered the Bay from the rivers leading from not only Maryland, but farms, municipal water treatment plants, and industrial developments in surrounding states. The watershed that produced pollutants was hundreds of times the size of the Bay itself, and every bit of algae producing phosphorous in that area found its way into the ecosystem.

The growing industrial base within the watershed also produced an assortment of poisons that could combine to reduce the oxygen levels of the bay, adversely affect the development of insect life who fed the fish, affect the spawning of fish, and produce infertile eggs in the waterfowl that ate both fish and insects, and sometimes (horrible cases) kill by direct contact. Her grant would be a small step in helping them evaluate how much the ecology could help itself.

Which was why she was once again ass deep in the oozing, sticky, and, at this time of year, chilly, black muck trying to find the boot that the ooze had snatched from her foot. On a nearby log were the scattered remains of her labors and the tools she had used, all scattered in her panic to remain upright as her foot had slipped when that stupid brown mutt had rushed out of the bushes and startled her. Now the dog's barking near her back drowned out the normally happy sounds of early marsh morning.

"Need some help?" the grizzled old waterman in the worn black sweater, torn jeans, and knee-high rubber boots asked her as he grabbed the dog's collar and pulled it back.

Mary looked up from the log where she lay with one arm immersed up to the elbow in cold mud. "No thanks. I just need to find my boot." There, she could feel the top of it now. "Your dog startled me. I wasn't expecting to see something that size charging out of the reeds at me." Damn, if her foot hadn't missed the log and plunged into the water she would have been all right. Luckily she had managed to grab a handful of bulrush or she would've toppled into the marsh and soaked all the way through, despite her working clothes. "Got it!" she said as she lifted the filthy, water-filled boot into the air, sat up, and, with a flourish, dumped the contents back into the water.

"You don't intend to put your foot back in that thing, do you?" the waterman asked. "I'd wash it out first."

What did he think she was, some fool tourist? Of course she knew that. Carefully she used the boot to scoop up some clean water and rinsed the inside. She repeated the process until the water poured clean and then shoved her foot into it and stood up.

"Don't get many visitors around here," the waterman said quietly, looking off across the marsh where a blue heron was stalking prey in the shallows with a slow dignity. She caught the glance he had given to her dissection tools and the samples she had taken. "Collecting roots, I see."

Mary had had enough experience

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with the people who lived along the Bay to understand that it was a question, not a statement. People here were leery of outsiders, strangers who had unknown reasons and strange viewpoints. "Mary Kelly," she said, extending her hand. "And no, I just need some samples of cattail roots for my work."

His grasp was surprisingly gentle, "Jake," he replied. "Appears I owe you something for what my dog did. Want some coffee?" he asked, and turned back the way he had come. Mary followed; perhaps if he were familiar with this particular patch of wetlands he could be of immense help to her study. "*Mariah's* safe, just don't go movin' around too much," he said laconically, as he picked up his pole and stood aside for her to step on board the frail vessel.

She looked at *Mariah's* scant three inches of freeboard. To her the boat was nothing more than a floating plank: it couldn't possibly bear their weight! Nevertheless it did, and she enjoyed the view it gave her of the marsh, so much better than the expensive little kayak she sometimes used in her own studies.

Coffee at Jake's shack was a revelation. The inside belied the ramshackle appearance of its exterior. Furnishings of the one room were few and spare; a bed, a small table that folded down from the wall, an easy chair woven of ropes and covered with canvas, and two stools that served both as dining chairs and side tables. Cabinets and storage lockers filled every available wall space, each one carefully labeled with contents. The kitchen would have fit into the space occupied by her own refrigerator; a small sink, a two burner propane stove, and a two foot square work area. A hatch in the floor, she learned, was where his cold box was suspended into the chilly waters during the winter months, providing natural refrigeration. In the summer he used a superinsulated box he'd built himself from plans he'd found in a copy of *Country Journal* at the library. Jake, it seemed, was an ingenious tinkerer, who made do with whatever fell to hand.

"Spent most of my life on boats," he remarked at one point, as he scratched the neck of a mangy looking gray cat that had climbed onto his lap. "Never felt I needed more than space to do what's necessary. Body's got to make his life fit his needs, not the other way around. Clears the mind for what's important."

Mary compared the ingenuity and simple elegance of what she was seeing with her parents' opulent house in Govans, crammed with their antiquities and furnishings that hardly got a second glance, so familiar were they. She particularly thought of her father's expensive stereo equipment, complete with the latest state of the art components from Japan and Sweden, expensive equipment that he seldom had the time to use. How many other items in their shallow lives were like that? How many items had she in her own life that she could do without? Sadly she could list a dozen without straining.

She explained her grant and why

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she was conducting the survey of selected wetlands from each shore at various points along the Bay, concentrating especially on places where the tributaries spilled their load into the Bay. She told him about the methods she used to analyze the uptake of the plants, trying to keep it to terms he might understand.

"Trouble is," she admitted, "We're dealing in boundary layer effects with the wetlands. We only get the part of the effluent stream that washed up to shore, into the marshes and swamps. We usually miss the main flow—that's out in the center of the rivers, and usually down deep."

"Don't have much growing out there," he replied. "Most of the sand bars are pretty barren, even the seagrass don't grow there."

Mary reflected, the delta buildups were natural sites for study, but there wasn't any flora there that she could use. Maybe she'd suggest to Shepherd that he take bottom samples and compare the accretion levels. Might even tie to another grant, if they were lucky. She recalled that someone had already employed oyster beds as collection sites, since each one filtered nearly fifty gallons of water a day.

Jake rose from his stool and took two steps to the kitchen corner. He pumped a little water from the cistern into a pot, added the rest of the hot water from the coffee and washed their cups. "Reckon we need to get busy. Lots to see in this here marsh."

Mary spent the rest of the day with Jake, recording the tidal flow patterns, the location of the various species of grasses, the striations of tidal rise, and the amount of spring water flowing into the marsh. "Carry most of my drinking water from the springs," Jake had remarked as they examined the one nearest his home. "When she's frozen over I use whatever's in the cistern or get some bottled from the marina. Best damn coffee water in the state." Of that Mary could not object.

Over the next five weeks, Jake worked side by side with Mary as she examined every wetland for miles on either side of his part of the eastern shore of the northern Bay. He showed her the gray clay outbanks where the ropey twisted roots of reeds ("Ammophilia," she called them) had anchored themselves. He showed her how the overhanging tufts of Sedge grasses along the stream banks protected the tiny shrimp and minnows that hid among their dangling roots. And he showed her the best places to observe the incredible assortment of animals that inhabited this abundant boundary between land and water.

And in return she showed him how to differentiate the varieties of seaweeds and introduced him to a fish and rice stew made with the iodine rich varieties; a Japanese recipe, she said. She carefully walked him through the lifecycles of most of the denizens of his marsh, and used her portable microscope to introduce him to ones he hadn't seen with his unaided eye.

And together they showed each other the wonders that made the Bay such a rich environment: a muskrat's long run to its burrow, a pair of egrets

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dancing in the reeds, a flock of mallards and pintails splashing to a landing/crash in the shallows, and schools of silver fish that darted before their boats as they drifted quietly in the afternoon.

They became friends and gained an understanding of each other. Her opinion changed from pity at his apparent poverty and lack of friends, to an understanding of how he had simplified his life so he could observe the simple beauty of the Bay and gain an appreciation of the wondrous bounty of this natural wonder. She found that, unlike her first thoughts, Jake was no Thoreau, creating a natural philosophy from his experience. No, he was content to experience life as it came, obtaining his satisfaction from the ebb and flow of the seasons and what they brought his way, and the company of his animals. He appeared to lack the drive and purpose that characterized most of the people in her life.

And, thinking about his solitary life here on the marsh, leaving society and all of its demands and responsibilities, she wondered about her rebellion. Had she really turned away from her parent's plans for her life? Or was she carrying on the example of service that she had learned from her mother? She was a dedicated researcher who was prepared to devote her life to her work, and was that so different from the career her father had encouraged her to pursue? Such were the thoughts that wandered in her mind as they stomped through the reeds and grasses.

* * *

Jake and Mary were beating *Gull* south on a stiff breeze one lazy afternoon. They had decided to take advantage of the beautiful day and use the small sailboat to visit one or two nearby sites. Out in the channel there was a demarcation line, where the outgoing tidal surge was carrying a load of soil from the north into the lower Bay, the result of heavy rains the week before. The clear waters along the shallower edges showed no discoloration.

"That's what's so frustrating," Mary remarked and pointed at the stain. "See how most of the effluents are carried right on by the wetlands so they don't have a chance to filter it before it gets farther down?

"And as a result it will shut out sunlight, cover the bottom dwellers, and cause a disruption in the ecosystem. Damn, if there were only some way to use the plants to filter it."

"Build a nice little island out there, maybe?" Jake said as he adjusted the tiller and brought the boat to a slight heel.

Mary sighed; it had been suggested before. "No, I'm afraid the cost of building up the bottom and maintaining it would be prohibitive. Besides, I think the dredging required would do more harm than good."

Jake looked thoughtful. Maybe there was a way that she hadn't considered; he'd have to think on it when he had time.

Chessie was nowhere to be seen when Jake returned from his hard winter's day of oystering. He'd been up long before dawn to join the rest

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of the tonging crew as they headed out to the oyster bars. Through the morning hours he had operated the tongs, sprayed the muck off the load with icy-cold water, and shoveled the oysters onto the conveyor. He could still feel the bone-chilling cold that had penetrated the heavy rubber gloves that protected his hands from the sharp edges of the barnacles and oysters. But his day's work was done, and he looked forward to a warm dinner and soft bed. Thank heavens he didn't have to do this all the time. So far this year he had earned enough to keep him going until crabbing season came. He wondered where the dog had gone.

As he tied the canoe fast and climbed up to the walkway he saw that the light was on. Someone was in his house! Carefully he opened the door and peered inside.

Mary Kelly sat on his bed, legs curled beneath her, surrounded by cats, and with Chessie contentedly curled at her feet. On the table sat a roasted chicken, two bowls of steaming vegetables, and a bottle of wine. "About time," she said by way of greeting. "Wash up and sit down before the food gets cold."

"Took a shower over to the docks," he said, dropping the bag of wet work clothing at his feet. Damn if that table didn't look inviting, he thought as he sat down and accepted the glass of wine she offered.

"Felt you deserved something special for all the help," she said by way of explanation. "You gave me a lot of your time last autumn."

"Well, a hot meal and good company on a chilly evening are a nice payment, not that you needed to repay me. What you're doing for the Bay would be enough."

Mary laughed at the compliment. "This isn't the payment. The dinner is just a treat I thought I'd give you while I explained the real gift. But that will wait till after dinner. Now let's dig in before it really gets cold."

Jake looked at her quizzically, but followed her orders. After all, he hadn't had an intimate little meal with a woman, or even a friend, for a long time. If it felt this good maybe he would do it more often, although it probably wouldn't be the same with Randy Jim or Hairy Bill, both of whom would be happy with beer and sausages.

Of course talk turned to Mary's work. She had found four species that absorbed heavy metals, and two that absorbed dissolved silicates and fixed them into their rigid stalks. She told him of how the early statistics showed the absorption varied in proportion to the tidal differences at the various sites.

"But we're just looking at 10 percent of all the water that flows down the Bay. And most of what we're seeing is just side wash flushing back and forth."

"Still think you need an island," Jake suggested.

"Right, I just wish it were possible."

Mary's surprise turned out to be a box of hose, some polyethylene piping, two gallons of black paint, a sheet of plastic, and some lumber. "It's to give you some hot water," she re-

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marked as he helped her carry the load from where her car was parked on the rutted road. "I've got the plans on how to make this stuff into a solar water heater you can install on your roof. Probably won't produce more than luke-warm water in the winter, but that's better than you have now."

The best gift is one that teaches you or gives you tools you can use elsewhere, and this was no exception. One glance at the plans she handed him told him that there would be many an enjoyable hour assembling the rig and figuring how to get the most from it. And he could see how the ideas in the plans could be used to improve his cold box. It was a gift from a real friend.

Mary returned to her apartment after a grueling week collecting samples from the western shore of the lower Bay. Spring had been a joy, the wettest in years, bringing the grasses she was studying to a fullness of growth that was astounding. Since the uptake of the growing plants after their winter dormancy was a critical factor in her studies she had to advance her collection schedule by nearly a month, racing to cover ground that she had barely begun to survey.

The rest of the summer had followed the hectic pace set by the early spring growth. For most of the summer months it had been dawn to dark days, working her two recently assigned graduate students like coolies, forcing the plants to tell their story about the Bay, fulfilling her grant and exceeding her expectations.

September had been a surprise with its early chill and darkening days. For the last two weeks she had been working in water, and grim skies raining half the time. All she wanted now was a hot bath, a soft bed, and two days of uninterrupted sleep.

The mail included something from Jake. "Come visit. Have a surprise for you." he had scrawled on the back of an old and inappropriate "Ocean City—Vacation Wonderland" picture post card.

"Thought about your problem of putting your plants in the channel flow," he said as they untied *Handsome*, the canoe, and climbed aboard a few days later. She had altered her schedule to allow herself a day's diversion to Jake's shack, leaving her two graduate students to struggle with the Middle Bay collection effort on their own. Do their souls good to do humble, mind-numbing work; after all what else were grad students for?

"My old bait box gave me the idea," Jake continued as he took his place in the stern and held the canoe steady to the dock while Mary climbed aboard. "Always had a problem with scum and seaweed growing on 'er, even a stand of grass took root on it in the spring.

"Anyhow, looking at my old bait box gave me the idea for the thing. Figured if I made it bigger she just might do the trick."

"What are you talking about?" Mary asked. Bait boxes, spring grass, and her flora uptake problem didn't seem to mesh. What had Jake done? The canoe drifted free as she settled and

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Jake immediately swung the bow around to head out into the creek.

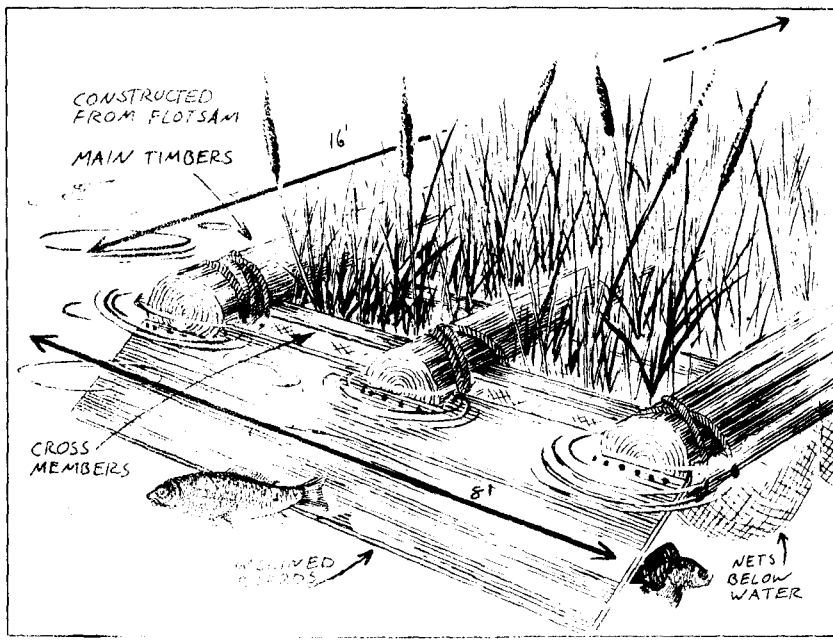
At first she didn't understand what she was seeing when they approached. It looked like an island had sprung to life a short distance from shore. Had Jake built up a natural uprising and planted grasses? The work involved seemed too much for one old waterman, especially since one good storm would wipe it out.

As they came closer she noticed that the grasses were bobbing with the waves, a steady undulation that didn't jibe with her island idea. She could see the edges of heavy timbers along the edge.

Suddenly her mind made sense of what she was seeing. Jake had used the old aquaculture idea of floating islands and, adapting it to her needs, had planted a collection of marsh plants on the surface.

"Hung a net under the logs and loaded it with straw, moss, and sand," he said by way of explanation. "Figured the plants needed to have something they could get a grip on." Yes, now that she was closer she could see that the plants were halfway immersed in the water, not standing above it. But Jake hadn't just built a floating planter, she noted. At both ends he had attached sloping planks to allow birds, crabs, and other denizens of the Bay to climb aboard and live among the grasses, just as they would on the beach. Already the barnacles and mussels had colonized the lower reaches. She could even see eel-grasses and sea lettuce sprouting.

The canoe bumped up against the



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thick log. It appeared to be pretty old, and probably already infested with shipworms, the termites of the sea. She leaned forward and placed her nose just inches from the surface of the water. She noted how the little green bull minnows and alewives darted among the roots of the plants dangling into the water below the raft, feeding on the microscopic life that infested them. She lifted her head and looked closer at the raft. Near the center she saw horsetail and cord grass, both sand binders that would trap silt and form a heavy root mat for smaller plants. He'd put wild rice, water oaks, near the edges where the ducks could feed, and planted twig rush among them.

In her mind's eye Mary could see how this simple idea for a floating marsh would grow. All varieties of aquatic animals and plants would attach themselves to the under surfaces and add their filtration power to that of the raft. Maybe oysters could be induced to grow on a shelf hung lower in the water; somewhere she had seen bags of oysters being used on piers for that purpose. Both oysters and barnacles had the capacity to filter enormous amounts of water—something like fifty gallons a day each, if she remembered correctly.

Yes, and a net halfway between the top and the bottom could provide a nice habitat for sea grasses such as green-tuft, widgeon, and Enteromorphia. Let's see, she estimated the displacement of the raft and figured it to be capable of holding nearly a quarter ton of burden, more than enough for a good assortment of plants. But what if they used a lightweight material, such as poly pipe instead of logs? That would hold nearly half a ton, more than enough to form a sustainable colony. Quickly she calculated that the total cost of the final platform she envisioned couldn't be more than a few hundred dollars, add another five hundred for the mushroom anchors that would hold them in place and she would have the perfect collection system.

No! Collection system be damned. Jake's floatant was more than that. It was a possible answer to a small part of the pollution problem. By anchoring enough of these in the mouths of the tributaries feeding the Bay they would filter the water flowing through. What was more, their vegetation would provide an early warning about dangerous pollution: The ecology of the rafts would be the first affected and, by analyzing the roots, they would give the answer to whatever ailed them.

"Thought I'd return the favor of the hot water heater," he said, as he gently guided the canoe around the raft. "Do you like it?"

Like it? Wait until she developed this some more and showed it to Shepherd. "Yes," she replied simply. He had returned her favor in kind and given her a tool that she could use. It was a more wondrous idea that he'd given her than ever he knew. "Thank you, Jake," she said. ■

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Probability Zero

A GLANCE BACKWARD

Ian Randal Strock

Tom, from Paleontology, plops himself into my guest chair.

"You look beat, Tom."

"You try solving a 65 million-year-old mystery and see how you look after a while."

I know I look much happier than Tom. I'm wearing an idiot grin and drinking champagne out of a paper cup.

Tom looks at my face, and his scowl deepens. "So, tell me," he growls.

I tell him. Twenty minutes ago we finally succeeded in capturing and stabilizing a wormhole for a few seconds in the physics lab. Actually, we'd caught one end of it in the lab. The other, as near as we could tell, was about four minutes in the past out around Mars. But we'd kept it and even widened it a bit.

"I don't get it," he rumbles.Tom is not a polymath.

"Do you even know what a wormhole is?" I ask.

"Something a worm leaves in the dirt?"

"A wormhole," I say in my best lecture voice, "is a tunnel, spontaneously formed by quantum fluctuations, that sometimes persists after its formation, and that connects two otherwise unconnected points in space-time."

"What?"

"It's a tunnel through space and time."

"Hey, that's great," Tom brightens. "Can you let me take a look at Earth 65 million years ago—to see what happened to the dinosaurs?"

"It doesn't work that way," I explain. "We don't make wormholes. We use what we can find. The two ends get separated in time when one accelerates and the other doesn't. The greater the separation, the less chance we have of finding one, and 65 million years is a *long* time."

"Well, work on it," Tom says. "It might be the thing to get me my doctorate."

That's a sore spot. We're both grad students but I'm in a new field, where finding something new to work on, like wormholes, is easy. Paleontology's kind of old—harder to find a thesis topic in.

"I'll work on it," I say. "But the longest wormhole we've found so far was about twenty-seven minutes, and we couldn't hold on to it. If we could get more powerful magnets, and a

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better generator, maybe we'd have a better chance."

"I'll see what I can do," Tom says. He's always been a good scrounger.

Four months later, Tom's helped get us a huge combined grant from the NSF—combining the studies of wormholes and paleontology. We've got money to throw at all the equipment we could want.

We find a wormhole something like 100 years long, and we're actually able to hold on to it for three hours—long enough to realize we can steer the other end . . . a little.

Tom's in the lab, but he seems really down amongst our elation.

"What?" I ask.

"Only 100 years? That's nothing. We need 65 million."

I shake my head and walk away.

A year later, we've been having more success. We've got a wormhole that goes back about 2,000 years —the other end was somewhere in the Oort Cloud when we found it —and we saw the nova that led the three . . . well, you know.

Anyway, we've been able to steer the other end in toward the planets—really slowly, but it's amazing what you can do with a good particle accelerator and all the money you can use. When science connects to "real world" interests, grants flow like water (of course, the Church's little donation didn't hurt either).

Tom somehow convinced the university to give him his doctorate, even though we still haven't been able to find a wormhole back to the K-T . . . multi-million-year-old wormholes are not that common.

The grant money's slowing down. Everyone's seen the pictures of the Universe a few million years ago and it's getting hard to make the spectacular discoveries that grab headlines and funding.

Tom's in town for a paleontology conference. "You're getting a little gray," he says.

"You're no spring chicken, either," I respond. It seems this has been our opening for years.

"Still haven't figured out what happened to my dinosaurs, have you?"

A grad student runs into my office. "Doctor, come quick. We've got a long one."

"How long?" I ask. I'm getting jaded in my old age.

"Dr. Stewart isn't sure. On the order of 60 million years or so."

Tom's eyes sparkle as he jumps up.

We get to the lab as Stewart is saying " . . . old. About 66 million years. It's definitely Earth. See the different continents?"

"And where's the other end?" I ask.

"About half a million kilometers off the surface. Hey! That looks like another moon! Smaller. I'm steering the 'hole for a better look."

I glance through. "Stewart, it's coming this way—"

"Tell me, Gurrgh," says Khggah, thumping his tail, "what do you think killed the trilobites?"

"I don't know," Gurrgh says, looking up into the sky and seeing the smaller moon disappear. The ground starts to tremble. ■

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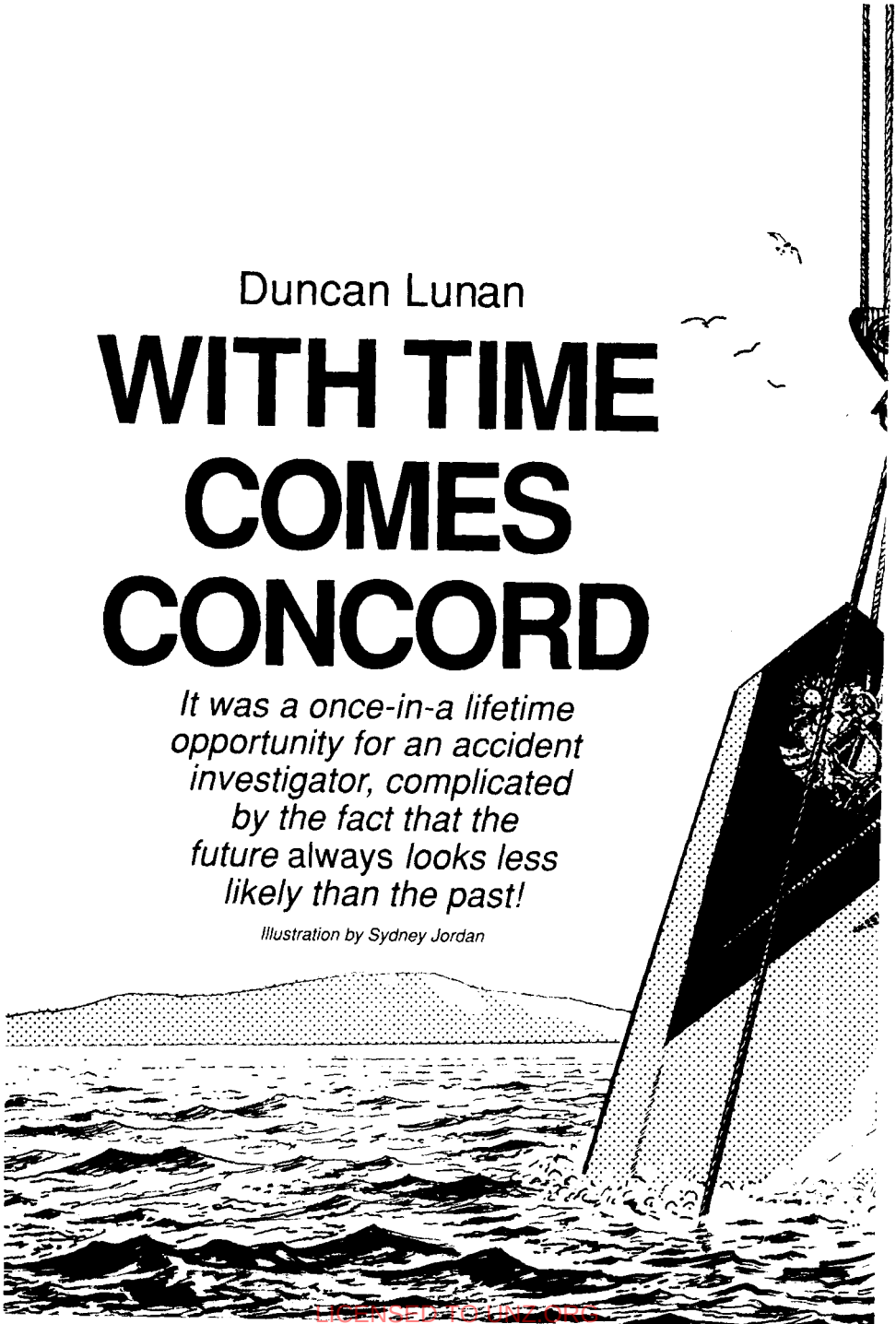
Duncan Lunan

WITH TIME COMES CONCORD

It was a once-in-a lifetime opportunity for an accident investigator, complicated by the fact that the future always looks less likely than the past!

Illustration by Sydney Jordan



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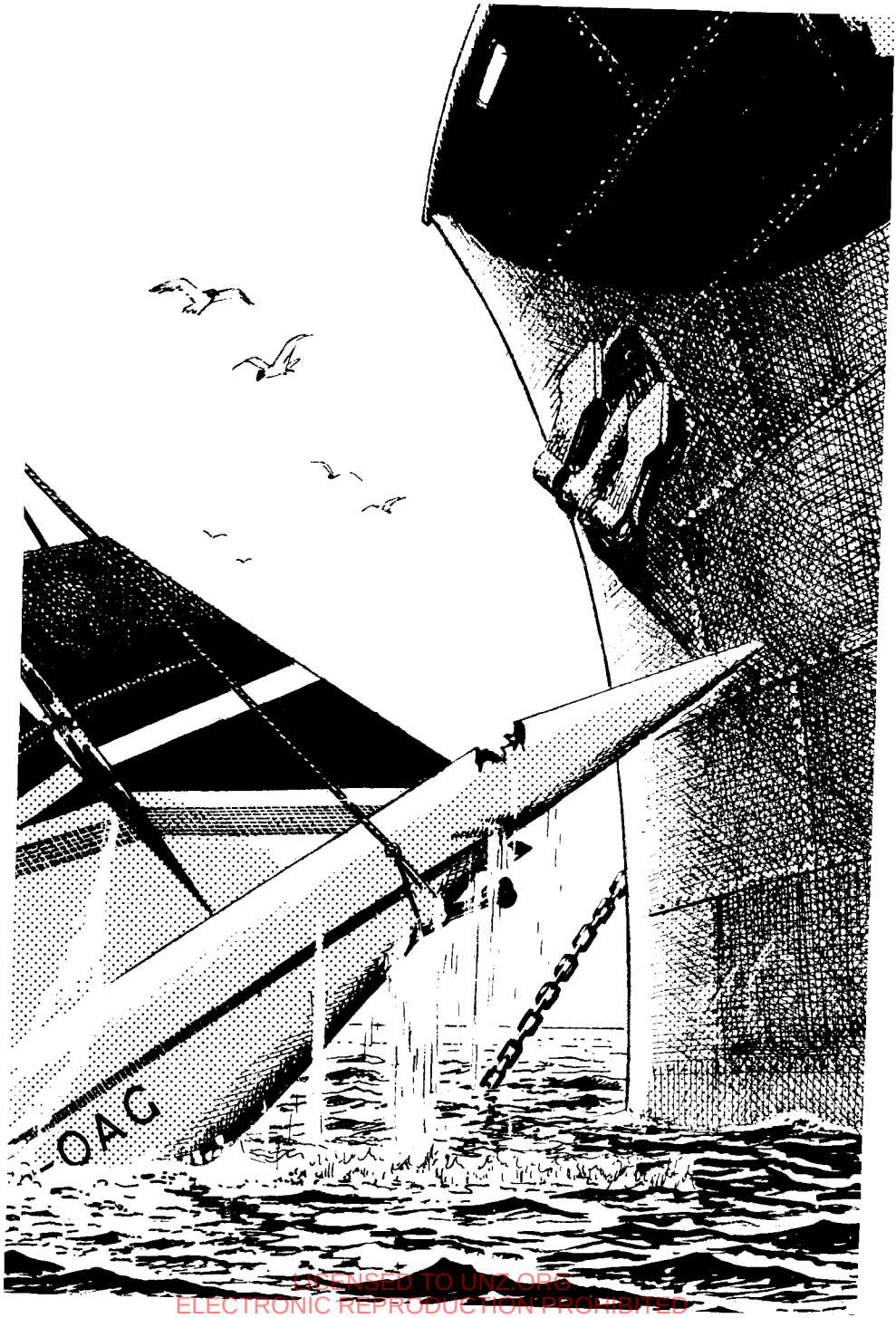

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Pendleton had picked a poor time of day for his visit to Farnborough. In spring, summer, and autumn the roads round the airfield were beautiful, thickly wooded, a pastoral setting in which the red-and-white Ministry of Defence direction signs would always seem incongruous. On this grey March day in 1969, after 5 P.M. and darkening early in the rain, the signs seemed more appropriate among the leafless trees: although some of the newer Ministry of Transport ones, like "Tank Crossing," with its appropriate symbol inside the new-format European red triangle, still seemed wildly bizarre.

The hangars allocated to the Accident Section were on the south side of the airfield, near where the aviation pioneer S.F. Cody had built his string-and-bamboo plane. They needed some romantic connection on a day like this. As he followed the perimeter track the runways were swept by sheets of rain, away from the protection of the trees. A far cry from the glamor of the summer air shows, with Raymond Baxter's enthusiastic commentary broadcast to the nation.

Nevertheless, here he was: John Pendleton, ex-flight lieutenant (RAF), ex-air traffic controller (Ministry of Civil Aviation, Prestwick) and now in the job he had been wangling for—inspector of accidents (Operations), in training, Accident Investigation Branch, Board of Trade; reporting to the Royal Aircraft Establishment for his first assignment.

Hangar T-49 was the largest, able to house several aircraft reconstructions at once, lit by seemingly endless rows of overhead lights. Hot-air blowers struggled to beat the cold and damp outside. Spread over the floor, in great piles, were tons of metal wreckage—much of it unrecognisable, but parts all too obviously from a civil Viscount. The tail assembly, almost intact and propped up on a wooden frame in the distance, bore the British Midland logo; the crash had been on takeoff during a training flight from Manchester, just days before. A detailed plan of the airliner had been chalked on the floor, like the outline of a murder victim—though this was not where the "deceased" had fallen. Among the wreckage two men squatted, in civvies like himself. Occasionally one of them would pick up a piece of metal, examine it, shake his head and put it back. A third, looking on, beckoned him over.

"John Pendleton, reporting."

"Bill Carstairs; I'm the inspector (Engineering) on the current 'go-team.' This one has nothing to do with you," Carstairs went on, indicating the wreckage around them. "I was just looking over these chaps' shoulders till you got here—we'll leave them to get on with it. You know what the situation is? New fellas start off on light aircraft, and work up from there?"

"That's how it was explained to me," said Pendleton.

"Right. Well, it looks as if we have one in the Hebrides—you'll have been briefed on that? Three bodies have been found on the western shore of South Uist, and the doctor in Lochboisdale thinks they died from a plane crash. He's reported it to the

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local police, and it's gone up the chair until it reached the gate at which the big boss in London was notified. Now it's an AIB matter, and it needs you, me, and a qualified flight surgeon, which the RAF will supply. The Commander Flying here has fixed us seats on a Hercules to Benbecula at nineteen hundred hours. I take it you're all packed and ready to go?"

"Yes, except for parking my car. I'm only in a temporary space."

"Hand in your keys at the office, they'll take care of that for you. Listen, I know you're being thrown in at the deep end, but it's a baptism of fire for you. For as long as you remain with this branch, when you're on the Readiness Roster, you can be sent anywhere in the world that you're needed, and the rest of us move up. In theory we can all be sent to Kuala Lumpur or worse, tomorrow, if we have to be. Is there anyone you have to notify? Wife? Girlfriend? Family?"

"No, there isn't anyone. Not at the moment."

"Fine. But this is something to remember for the future: wife, family, kids, you can't make any commitments to them that are binding except when you're on annual leave. Maybe not even then, if we have a really bad one. That's what you've signed up for, and it's as well to know that right at the start."

Carstairs was voluble, even garrulous, Pendleton realised as they prepared for the flight. It could become irritating, but for the moment, when he had so much to learn, it was invaluable.

"...Since the Chief briefed you first, you're in charge of the investigation. That gives you very considerable powers. You've been appointed to the inspectorate by the Secretary of State, remember; once the Chief has decided there is to be an investigation, and he puts you in charge, even he can't take you off it. His decision can't be reversed, and you're protected by law from any kind of political pressure. There's not another country on Earth that gives its inspectorate such autonomy."

"The only reason I was first was that I was in his office at the time!" Pendleton protested. "Essentially, he put down the phone and said, 'Would you like to start today?' "

"Well, make the most of it. The one thing you will have to watch, since there are fatalities involved, is that there can be conflicts with local coroners. An inquest is only supposed to determine the cause of death, but some coroners take that to include the cause of the accident, and try to apportion blame. Where it can get tricky is that they have powers to impound evidence, which would affect our work, of course, so you have to try to ensure that kind of conflict doesn't arise.... There are a lot of pitfalls to watch for."

The conversation swiftly grew more technical. "Know your wreckage!" evidently was the Branch watchword, and Carstairs seemed to know every aspect of the trade. By the time they boarded the Hercules, he had covered control surfaces, airbrakes, trim tabs, flaps, undercarriage, control settings, fuel cocks, extinguishers, electrical circuitry, hydrau-

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lics and a dozen other topics, all in relation to the first basic question: what was the state of the aircraft immediately before its end?

"The public thinks the black boxes tell us everything we need to know. They're shifting to flame orange now, by the way, they used to be yellow. But all they tell you is height, airspeed, attitude and compass heading: the newer ones record more parameters, but there's still no substitute for detailed knowledge of your wreckage. The cockpit voice recorders can be helpful, but usually when we turn to them we're looking for pilot error. If the aeroplane was all right before the impact, or was doing something really odd, it helps to know what the pilots *thought* was happening. With single-seat aircraft, you don't even have that advantage: we've just had a US pilot killed on a Harrier conversion course. He was distracted by a jubilee clip which came off an airhose; and the only reason we know that is because it happened to another pilot, during the transition to hover, but he managed to stay in control. . . ."

In the echoing hold of the cargo aircraft, conversation was more difficult. Pendleton was glad of a pause in the increasingly technical flow of information. Invaluable as it was, the distilled wisdom of a lifetime in air crash investigation, he needed to absorb it in manageable doses. They landed at Benbecula near midnight, still in driving rain, so nothing useful could be done till the morning. Pendleton noticed the smell of the sea as soon as he left the aircraft, a reminder of his traffic control days at Prestwick. His billet brought back earlier memories, of his own years in the RAF: but he wasted little time on nostalgia, expecting a long day tomorrow.

Next morning, under grey, driving clouds, he and Carstairs signed out a car from the motor pool and drove down to Lochboisdale. The road gave them only one view of the sea, from the causeway linking Benbecula to South Uist. Long white breakers rolled in from the west, perhaps bringing more traces of the aircraft for whose loss he would have to account. But first he would have to identify it: nothing had yet been reported missing, and police interest was growing.

"It's not likely to be illegal immigrants, this far north," said Carstairs, as they followed the bumpy road down the island. "But it could be drugs. I had breakfast with the Intelligence Officer, to pick his brains. The Hebrides are one of the routes into the UK, because of the large number of foreign trawlers. Airborne deliveries would be a new trend. But it could be an intelligence job. The Soviets monitor the rocket range, of course, and the torpedo trials in the Minch, but most of all the nuclear submarines in and out of the Holy Loch. You can hardly see some of their trawlers for the electronic gear they're carrying. But for dropping agents and picking them up, again they work mostly by sea: at most harbours you can just walk off, and there are thousands of beaches and inlets where you can put a boat in. If it was worth the risk of sending in a plane, it could

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be a major operation."

Sure enough, when they reported to the police station, there was a plain-clothes man to escort them to the mortuary. Knowing how few of the islands had even a special constable, Pendleton was suitably impressed.

The doctor, a local man, was expecting them to be impressed with the state of the bodies. "You'll be wanting to bring your own pathologists in on this one, I'm thinking," he said as he drew back the sheet.

Pendleton had seen crash effects before, but not like these. "What caused those injuries?" he asked. "Fish?"

Carstairs gave him a scornful look. "We don't have piranha in Scottish waters, Jack. These are wind-blast injuries: supersonic airstream, or near it. That could be consistent with the nakedness: I take it this is how they were found?" The doctor nodded. "Mind you, I'd have expected flying gear to be torn, rather than ripped right off. And we don't have any high-performance aircraft missing.... I think the Intelligence chaps are going to be *very* interested in this one."

In that, he was correct. The Soviets were penetrating British airspace at altitude on a regular weekly basis, but with old-fashioned Bear and Bison bombers, testing their Electronic Counter-Measures against far superior systems in which Britain was the world leader. If they had something big which could operate at transonic speed, undetected, that was a very different matter.

By the time Pendleton and Carstairs got back to Benbecula, the rocket range recovery boats had been deployed and Coastal Command was sending a Shackleton from Lossiemouth. These were his decisions, Pendleton realised, actions he could have taken if his investigation warranted it, now taken out of his hands. But at least he was still on the case and had the opportunity to learn.

The old '40s aircraft, "40,000 rivets flying in formation," roared low over the airfield before turning out to sea. Monitoring the search from the control tower, Pendleton and Carstairs marked off the squares of ocean which had been checked. They discussed using trawlers and the local lifeboat, but with the intelligence aspects so dominating it seemed better to stick with military personnel. Fortunately the area had been closed to shipping for the next series of rocket range firings.

When the results came, they were dramatic.

"Tango George, say again—*how* many bodies floating? Over."

"At least fifteen bodies counted, Tower. A large kidney-shaped fuel slick, large amounts of flotsam. We're dropping chaff for the radar fix on this pass, smoke floats and dye markers for the boats on the next one. Then we'll extend the search pattern downwind, over."

"That's up to twenty bodies so far!" he exclaimed. "It's as if an SST has come apart. What the hell is going on?"

"If it is a supersonic transport, you'll make air crash history," said

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Carstairs. "You'll be the first inspector to work on an aircraft type before it's started flight testing—at least in this country. Has anyone checked whether the French Concorde is still in one piece?"

It was intended to be humorous. The first Concorde flight at Toulouse was only three weeks before; the British counterpart, not scheduled till next month. The Soviet Tu-144 had flown at the turn of the year, but little was known about it. It would be madness for either to be carrying such numbers of people, at high Mach, so early in the programmes.

"We have another report from the Shack.," said the tower operator. "A second slick, ten miles nor-nor-west. More flotsam . . . ten bodies sighted on first pass . . . several women, apparently some children. . . . "

"Whatever else it is, it's not military," said Carstairs. "Back to us, till we find out whose it is . . . Jack, can I make some suggestions?"

"I wish you would!" said Pendleton. "What do we do next?"

"As soon as we get the post-mortem results on the first bodies, we'll know how long they've been in the water. We need to backtrack on currents and surface winds, to try to find the impact points. We can try dropping a line of floats out there, to see how they drift in a corresponding period, but that may not work: it didn't in the '59 Victor investigation. We tried it twice and they all went the wrong way."

"If we find the main wreckage, can we raise it?"

"You may not need it. With the '67 Comet off Nicosia, we didn't recover from the bottom because it was in 11,000 feet of water, and we were able to determine the cause without it. But at this stage, when you don't even know what *type* of aircraft is involved—and it looks as if someone is covering up—at least you want to know where it is. Normally we'd commission civilian trawlers to make a sonar search, but to keep this thing under wraps, ask for torpedo recovery vessels from the Minch. Royal Navy salvage, too, at least on standby. You may need diving bells, underwater cameras, and lifting gear before this is over."

A week later, the Ministry of Defence had made all necessary facilities available and a full security blackout had been imposed. Pendleton and Carstairs briefed the recovery crews on the work of the Branch, the importance of the evidence coming in: Pendleton let Carstairs do most of the talking, because it had to stick to generalities. "Ordinarily, we'd be explaining the investigation in depth. We'd be telling them all about the aircraft, what we know happened to it, what we have to find out. As the reconstruction built up, we'd take them to Farnborough to see it, let them know the value of what they've found and what we're still looking for. And normally, the search team would be a mix of civilian and military. None of that applies this time, either because we don't know the answers at all or because what we know so far doesn't make sense."

With every boat that put back in,

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the problem worsened. The AIB team was now up to six, though the protocol that Pendleton was in charge was scrupulously observed. All bodies and wreckage had to be documented: sex, age, state and degree of clothing, jewellery etc., position in the water and in the search grid—and for this they were dependent mostly on the coxswains of the recovery vessels, with whom they had to maintain constant liaison. The bodies divided sharply into two groups: the naked ones, badly injured and soaked in fuel, though with no burning, were from the southerly group. The others had apparently floated free from the impact, since injuries were minor. Clothing mostly was disarrayed or detached, implying violent cabin decompression.

One early exception was a young woman of quite extraordinary beauty. Her face had escaped injury, and her expression, unlike most of the others, was almost ethereally calm. Her body was uninjured, as far as could be told, because it was sheathed in a one-piece garment like a leotard or a body stocking which defied attempts to cut it away.

"It's no fabric I've ever seen," said the flight surgeon. "It's woven, so it allows perspiration—you could take a bath in it and maybe even sunbathe, if you needed that extra protection. And yet it's impervious to the sharpest blades I have. It's as if it's a single, monomolecular fibre. I'd say it was body armour, if it weren't for the colours: they're not exactly military." Though mostly black, the fabric was shot through with kaleidoscopic

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streaks, blurred by diffraction at the edges.

"Or an all-over chastity belt," said his assistant.

"Well, she doesn't *look* Moslem; and she'd have to be the daughter of a Sheikh or a Maharajah, to make it worth the development cost of something like this."

The flotsam, too, was divided, with inflated life-jackets, personal belongings, and fire-extinguishers in the north; cabin furnishings, seat cushions, and carpets in the south. This too resembled the 1967 Comet loss, which had been caused by a bomb in the after part of the cabin. Whatever they were after, apparently it had broken apart at altitude and at speed, but a large part of the airframe might be intact.

The search area was extended now over the whole eighty miles to St. Kilda, the most westerly outcrop of the British Isles. Such a long track was unknown in previous AIB experience, but consistent with the near-supersonic airstream to which the southerly bodies had been subjected—provided the initial breakup had been at 30,000 feet or more, in the range of military aircraft like the Canberra. It was a big area to search, but as larger and more recognisable pieces were found the incredible had to be faced.

"The investigation's definitely in your hands now, Jack," said Carstairs. They were in the electronics shack of a submarine salvage vessel, red-lit and filled with the smell of singeing dust and hot solder. On the screen was the flickering picture from a camera 200 feet below. "There's no question whose nationality it is. That's the Union flag, boy, and I don't mean the American north. But I've never seen it shaped into half an arrowhead before. Whose bloody logo is *that?*"

"It could be anyone's," said Pendleton. "Any UK airline, at any rate."

"How so?"

"Because it's perfectly obvious what that is: it's the tail fin of a Concorde. Even though it won't be carrying passengers for years yet, and even though we don't recognise the markings, we have to face it. We've got one, with at least fifty occupants, even before we raise the fuselage from the sea-bed. It's a regular airline flight, we know that from the cabin luggage. On that timescale, any airline can change a livery—BEA's been through three in this decade."

"On that timescale? What the hell d'you mean?"

"Just that we have to accept what we're looking at, however hard it is to believe. The papers and magazines we're fishing out are dated 1999; this aircraft is from the future."

"We have a hypothesis before us," said Harrison, the Intelligence captain, "namely, that an aircraft has come back in time. A large volume of alleged evidence has been passed to my department, after drying out and treatment to remove salt and aviation fuel. Much of it has been damaged in the process, and testing its authenticity will now be very difficult."

They were in the office of the chief inspector; in London, in Shell-Mex House overlooking the Thames, but

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without any presence from government or higher levels of the Civil Service—the immunity of the AIB was being upheld, even on this most sensitive issue. Spring had come to England, though not yet to the north: the trees around Farnborough were in leaf, the Sun shone outside. The tail-fin on the sea-bed, found only days before the event, was not enough to prevent the British Concorde's maiden flight from Filton. Raymond Baxter had done the commentary, though on the *Apollo* mission coverage he had handed over to James Burke. Today's question, crucially, was whether further tests should be suspended and the French government should be informed. With the indications seeming to point to sabotage, and that far in the future, Pendleton had not so far recommended it.

"We have a hypothesis," said Harrison again. "What is the evidence for it? Wreckage, from an aircraft type which is already in existence. Bodies, which could have come from any illicit source. And a large amount of the 'evidence,' which I mentioned just now.

"What are the other possible explanations for these? For the first, scrap production components, dumped on the sea-bed under cover of a storm. For the second—people die every day, of causes natural and otherwise. With money, bodies can be obtained—it's no coincidence, I submit, that far too many of these are Orientals—and there are wind-tunnels in which blast injuries can be simulated, masking other injuries or causes of death. With time to plan, the most convincing 'victims' can be selected. And for the rest, garbage, as shortly I shall show.

"Who would stand to gain by such a hoax? Opponents of the Concorde programme, on the grounds of cost; enemies of this country, antagonistic to its high-technology success; airlines looking for excuses to cancel options, in a worldwide recession in air travel; environmental groups, anxious to discredit the programme; terrorist groups, wishing to embarrass the government; newspapers fabricating a sensational story. The whole thing could even be some kind of grisly simulation by the manufacturers, who after all are best placed to perpetrate it, if they foresee it going badly wrong in reality. Or more plausibly it could be by their rivals: the American Supersonic Transport programme is a political hot potato, with huge sums involved. And the only one which appears to me to be of any importance is that the Soviets already have their supersonic transport in the air.

"What I have to ask, professionally, is: are these less far-fetched than the future hypothesis? Obviously, the answer is yes. For the hypothesis to survive, the remaining evidence would have to be compelling indeed.

"Instead, as I said before, what we have is garbage—garbage which shows its socialist origins, though some of the devices are subtle. For example: from the literature, we're asked to believe that by the end of this century the Soviet Union has broken up, its member states have capi-

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talist economies, America and Russia are firm friends and in the last stages of scrapping their nuclear arsenals. So there would be no point in building them up now, would there, gentlemen? No need to upgrade Polaris, no need for Chevaline—not that we can use that word outside this office. In the immortal words of the Duke of Wellington, if you believe that, you will believe anything.

"Much of the rest of it is more explicit. For example, our national carrier is no longer the British Overseas Airways Corporation, but 'British Airways'—a fine socialist ring that has to it. This is its logo, which you found on the tail plane—here, supposedly, on plastic bags for in-flight off-duty sales. You can find the Union Jack better used in any outfitter's on Carnaby Street. Even the makers' name has been changed: no longer the British Aircraft Corporation, now it's 'British Aerospace'—something else which might appeal to the more extreme back-benchers, and their trade union backers.

"Mr. Pendleton asked us to pay particular attention to the literature concerning the future of spaceflight. Many of the passengers supposedly were going to a conference at the University of Colorado at Boulder, entitled "The Case for Mars"—4,000 miles on a side, with a big handle, I suppose. We have multiple copies of the purported conference programme. Some of the scientists named are real: Professor Carl Sagan and Dr. Brian O'Leary, for example, are genuine experts on the planet Mars, both currently at Cornell University. So I have taken your request to NASA Headquarters in Washington for a summary of current plans.

"There will be at least eleven Moon landings in the first phase, followed by temporary Moon bases and manned mobile laboratories, launched by more advanced versions of the Saturn V booster. There will be two temporary manned space stations called Skylab, followed in 1975 by a semi-permanent twelve-man station built by a reusable space plane called the Shuttle. By 1986 there will be two hundred Americans in space, thirty-five of them on or orbiting the Moon and twelve en route to Mars.

"Instead of which, we have here, in a 'potted history of space exploration,' that a four-man station called Freedom (by which I assume they mean Skylab 2) has only just been put up in 1999. Elsewhere it says nevertheless that Skylab 2 is in the 'Smithsonian Air & Space Museum,' which is as fictitious as the 'Planetary Society' said to be organising the congress. As for further exploration, it's as if it all stops dead after *Apollo 17*, only three years from now and in the middle of the current series of missions. Everyone I've spoken to in NASA assures me this is nonsense—wish-fulfilment by the Soviets. They even got a personal statement from Vice-President Spiro Agnew that he'd sacrifice his political career before allowing such a thing to happen.

"However, the Professor Sagan named here is emerging as a critic of the *Apollo* programme. Dr. O'Leary's position is even stronger: he resigned from astronaut training, with consid-

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erable publicity. I'm not sure that the target of this hoax really is Concorde: it's more as if it's aimed at the American space effort."

"You're speaking now as if you've established that it's a hoax," said the Chief Inspector.

"There are several types of hoax," said Harrison. "There are the successful ones where only the hoaxer knows he's pulled it off; there are the criminal or military ones which have to be successful at the time, but may be revealed later when the purpose has been served. And there are those which have to be revealed almost at once, to embarrass the victims, or to boost the hoaxer's ego. If the object of your 'wreck' is to embarrass the Americans or ourselves, it has to be in that category.

"What we have to look for then—testing my hypothesis now, not yours—are the deliberate absurdities, the things no sane person would have believed, which show what fools the victims are. And that brings us to the 'personal effects' of your corpses. I'll stick to the ones which are plainly absurd or inconsistent.

"1. Contraceptives. Almost everyone over the estimated age of fourteen is carrying them, almost all of them condoms—the women as well as the men, and even if they're supposedly on the pill in addition. What's that supposed to imply—some mysterious new sexual disease? Divine vengeance on the permissive society?

"2. Pocket calculators—current market cost just under 400 pounds, for a device which can add, subtract, multiply and divide. Far too many of these people have them, they're too small to be believable, and most of them have functions you can only get on a slide rule or a computer. Arc, sin, cos, tan, roots, reciprocals, in a box you can hold in your hand! Of course, after being subjected to decompression and immersion in salt water, strangely enough we can't find one that works to demonstrate these remarkable properties.

"3. Telephones—on the aircraft!—with push-buttons instead of dials, and funny little aerials instead of wires. Toys, nothing more.

"4. Typewriters—again far too many of them for any normal planeload of people, let alone Concorde passengers. Whoever they are, I can't see them doing their own typing, let alone on a three-hour flight across the Atlantic! But in any case, most of these things are toys; they don't have any paper in them, or anywhere to feed it in.

"5. Wristwatches. We now have quite a number of them, and they all agree on the time of the crash: but that's a detail any hoaxer would take care of. But most of them don't have hands—just what's supposed to be some kind of digital display. What use would a watch like that be to a boy scout? You couldn't even find south with it!"

"If you know the time of day," said the Chief, who was a keen yachtsman, "then you know where the bloody Sun is. Stick to the facts, please."

"Very well. There's some other funny stuff—plastic identity cards, issued by banks, for God's sake, not governments, and all with the same

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funny dark strip on the back. Far too many hearing aids, which apparently could play music tapes if they worked. But the main other point I want to make is about the literature. We don't have any newspapers, which wouldn't be surprising after a storm in the Atlantic, but it would take a lot more imagination to make up a convincing daily newspaper for thirty years hence.

"As for the magazines . . . ! Every crank, idealist political notion you can think of is here. Only one Germany, and yet strategic arms abolition and US withdrawal from Europe are nearing completion. United Europe . . . common currency—no passports, no trade barriers, *Channel Tunnel tickets!* Japanese electronics! Russian pop stars! 'UK to Have *Second* Woman Prime Minister'! Since there will be no in-flight movies on Concorde, our hoaxers have been spared the trouble of making one specially; but if there had been, I'll bet you it would have been a rerun of some 1960s trash like *Help* or *A Hard Day's Night*. And my reason for saying that is that the in-flight entertainment selection includes the London Symphony Orchestra playing "The Beatles' Classics." Just for the fun of it, I checked that one with a musicologist: apparently there is a chord in *She Loves You*, a flattened seventh or something, which was once used by Beethoven. That'll be the shortest music tape on record. It's utterly unbelievable, Chief Inspector, phoney from start to finish. You're an intelligent man; what's your opinion of the IRA?"

"What—the Irish Republican Army? A spent force, if ever there was one."

"Quite so. Well, according to what this supposed issue of *Time* calls a retrospective, next year—*next year*, mind you—the IRA will be back with a campaign which will bring the British armed forces to an impasse, and then hold the situation in Northern Ireland at that level for more than twenty years. What will end it is the collapse of foreign backing after the Soviet Union turns capitalist and unites with us for a war in the Middle East. As I've said before," said Harrison, looking pointedly at Pendleton, "if you can believe any of this, you're as crazy as whoever wrote it. You'll believe anything, sir."

"I have to believe the wreckage," said Pendleton. "There's an airliner full of bodies on the floor of the Atlantic, and nothing missing up in the sky. If it's not a Concorde, then what the hell is it?"

"It's a bloody fake, that's what it is. You're the only one here who's even considering anything different."

The Chief said nothing. "Bill?" said Pendleton.

"I have to agree, Jack," said Carstairs, with reluctance. "It's the small details that give it away. Like, these people are all supposedly so wealthy that they haven't a Bank of England pound note between them. In real life, the only people who don't carry small change are the Royal Family. Unless, of course, you count this dross." He indicated a pile of small coins, like washers, on the table. "You find it in the bottom of handbags, as

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you'd expect with transatlantic travellers, but the amounts are ridiculous. Take this Chinese-looking thing—'fifty pence.' Who's going to invent a coin worth four-and-tuppence?"

"That's a decimalisation," said Pendleton. "It's a year or two off yet, but the mint's been selling pre-release packs of those coins since last summer."

"Well, if they're on sale, any hoaxer can buy them," Harrison put in. "That's one of many points we checked."

"Be that as it may, what about this thing?" Carstairs held up one of the yellow "washers." "These are such poor fakes, the wording isn't even consistent. This dog-Latin on the edge varies from one coin to the next. And it's supposed to be a pound *coin*, in your small change! Do these people buy their drinks ten at a time?"

"In thirty years, that could be inflation," said Pendleton. It got a chorus of protest. "A pound for a *pint*?"

"Another socialist chimera," said Harrison. "The prime minister sorted out Robin Day on that one, on Monday night's *Panorama*. Inflation is not a problem in the British economy, and no government—no Conservative government at any rate—will ever take steps to contain it."

"The future never goes the way the experts predict," said Pendleton. "As recently as twelve years ago, Patrick Moore was saying there wouldn't be a Moon landing before 2030; when I was a boy, Professor Low was saying there wouldn't even be a Moon *rocket* for fifty years. For a comparison with what we're facing, I've been looking at a book called *The Dawn of Magic*. One of the authors was a French scientist who spent the war in a prison camp. When he was released and flown back to France, he couldn't believe the equipment on the plane—radar, radio, navigation, all a generation or more ahead of what he'd last seen—and the pilot talking about ballistic missiles and nuclear energy! He compared the experience to time travel, and he'd only been behind the wire for four years."

"*The Dawn of Magic* is about the bloody size of it, if you ask me," said Harrison. He opened his mouth to go on, but the Chief was obviously wearying of the flow of disparagement.

"This is Jack's investigation, and I think it's time to take some decisions. The Minister's waiting to hear from us, Jack: are there grounds to suspend the Concorde programme?"

"I don't think so. If it's genuine, and I think it is, this still looks most like a midair explosion, probably a bomb, within the cabin. I do want to go on with retrieval from the sea-bed, at least until we find the flight recorders."

"That's to have full priority, then," said the Chief. "We went through this in 1954, when the Minister resumed commercial Comet flights against the recommendations of the people here. That was before the wreckage was retrieved from the previous crash and the fatigue cracks were found, and it cost another airliner and every soul aboard. I won't have that happen again. If we let Concorde go ahead, even temporarily, then there has to be a total effort to establish the cause

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of the future accident—or prove it's a hoax.

"Let's suppose for a moment, wild as it seems, that it isn't a hoax. Jack, your only reason for suggesting a bomb is the similarity of the surface debris spread to Comet G-ARCO's. But you don't have any of the evidence we had then for a bomb: nothing the explosives experts can get to work on. And you can't inspect the engines because of the way the wings are lying on the sea-bed. If you're going to grapple them, turn them over for the cameras, then you may as well bring them up, and at that point we're on the way to a full reconstruction of the aircraft. If there's anything else you need, Jack, requisition it; you have the authority, and I'll back you."

Pendleton had digs now in Staines, convenient for both Farnborough and London. Driving home, he pulled off at Virginia Water, to think over the discussion more dispassionately. Whenever he thought about the fake hypothesis, somehow the girl's face came back to his mind. He agreed with the doctor's diagnosis, back under the flourescents in Lochboisdale: she was from a background of wealth and power, in which she was protected and probably loved. Even if her porous "armour" could be manufactured today, and he was still waiting for the ICI chemists' verdict on that, and if she had died from natural causes, could anyone bear to let her be dumped at night in the Atlantic, miles from land, on the offchance that she'd be found—and if so, remain unburied? None of the bodies could be laid to rest until this mystery was solved. And the other possibilities Harrison had hinted at: deliberate murder and experiment, building up a stock of suitably convincing "victims"—for someone like her, the thought was not seriously to be considered.

The pub was old-style, the way he liked them, still with hand-pulled beer in an age of plastic pumps and metal kegs. There was a new addition, though: a colour television, incongruous above the end of the bar. The landlord had been talking about it, in anticipation of the Moon landing, with a late license for his regulars. The evening news was on, as he slipped on to a bar stool to savour his pint.

". . . Crowds of screaming fans surrounded the Old Bailey today, and several fans were arrested after clashes with the police, when Mick Jagger and Marianne Faithfull appeared to answer charges of possessing cannabis resin. Their appearance in court was brief, and a trial date was set for January.

"The *Apollo 10* astronauts, now en route to the Moon, gave a TV broadcast earlier today in which they demonstrated equipment they will use, on the last space mission before the Moon landing in July. . . "

Cannabis resin? Could that explain the girl's unnatural calm, when she must have had *some* indication of the break-up of the aircraft? Already there were long-haired intellectuals saying the stuff should be legalised. In thirty years, maybe . . . but the thought of pot fumes in the air-circulation of a

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supersonic airliner was enough to give any pilot the hab-dabs.

"That's not possible," said the man at his elbow. It was disconcerting, as if his mind had been read.

"Beg pardon?"

"That," said the man, pointing at the screen. "Up till now I thought they were idiots, those people who say it's all being done in a TV studio. But I can't believe that."

"Why, what's wrong with it?" It had looked like a rerun of *Apollo 8* so far, though now the camera was going through into the Lunar Module.

"That demonstration he's just given of the onboard computer. Listen, I'm a systems analyst, I trained as a programmer with IBM. I can't get performance like that out of my company's mainframe, and he's saying he can get it from a box the size of a small typewriter!"

It was the second time that day he had heard the comparison. But if every businessman could have the equivalent of a mainframe in his lap; and a cordless phone—through satellites?—so that he could stay in touch with the office, then why burden himself with paper? Himself, or herself, since the women had them too. And if there was a revolution in business equality, why not in sexuality? Harrison's list of "impossibilities" might be long, but if he could believe any of them he could believe them all. The Concorde in the Hebrides was no hoax, and he saw what his responsibility would have to be now.

The recovery crews were all selected men, and the Intelligence presence was everywhere. They were lucky that the impacts had been west of the Uists, where the first bodies were spotted on the long beaches in time for the rest to be intercepted at sea. Had it been over the Minch, they might not have been found among the inlets of West Skye—not at least until so much had come ashore that the secret could never be kept. As it was, with so much retrieval going on out there and with no aircraft reported missing, the operation passed unnoticed.

Of course, they couldn't find everything. Enough was found by other people, and was strange enough, to set tongues wagging on both sides of the Minch. *The West Highland Free Press* flew the occasional kite; "Bodies But No Murder" was one of their more accurate headlines, had they known it. But the ministry line remained firm. "Nothing missing. Rumours? No comment." *Private Eye* got on to it, trying to link the rumours to their campaign about the Aer Lingus Viscount lost off the Royal Aircraft Establishment's own rocket range at Aberporth the previous year. But not even the satirical journal, fighting its way from lawsuit to lawsuit, could make anything of an RAE refusal to answer questions when no aircraft was missing at all.

If the reconstruction had been at Filton, the wreckage could be compared with actual aircraft complete or under construction; but that was out of the question. Instead the RAE Structures Department turned over still another hangar, T-50, where the operation could proceed in secret. A

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major airlift was organised to bring the wreckage to Farnborough, using everything from Beverleys to Herons, all shrouded in plastic or canvas to conceal it from the air and ground crews. The tang of the Hebridean sea came to the Accidents Section, the reconstruction hangar, labs and some of the offices smelling like the quay of a fishing port.

It was especially odd to be commuting from the Hebrides to Farnborough, in these circumstances. The contrast between the flat, near-treeless islands and the leafy lanes of Hampshire was startling enough; and then of course the difference in temperature; but most of all the sky. In Scotland in June and July, especially in the north, twilight lasted all night unless hidden by clouds; in the south of England, the sky was jet black and the stars were brilliant, all the way down to the horizon, not even hidden by the Hebridean haze. He could walk out of the sea-smelling hangar, let his eyes adjust, and see the Milky Way and the Andromeda Nebula—invisible, at this time of year, where those smells belonged.

The tail section, with its puzzling logo, was among the first to be raised. "I don't believe *that* at all," said Carstairs, pointing to the registration number.

"G-BOAG—what's the matter with that?"

"You'd know if you were from civil aviation, instead of military. BOAC use the letters G-BOAC on every piece of promotional artwork, for every aircraft type. It drives plane spotters mad because they can't tell whether the illustration shows a real aeroplane. And that reg. isn't different enough to be plausible."

As the sorting out began, allocating pieces to their positions on the chalk diagram and the rising wooden frames, a list of part numbers began to be compiled. Discreet enquiries at Filton established that they were later in the production series than for any aircraft built yet. Confirmation that production would continue would have been welcome to the workforce there, worried about their jobs: the campaign against Concorde was continuing, prominently featuring Mary Goldring of the *Observer*, and Members of Parliament raised Cain in the House when it was announced that costs were already 62 percent higher than the last estimate of 450 million pounds, just three years before.

Leeds United won the football league; Blakeney won the Derby. England, led by Boycott and Illingworth against the West Indies in the Test, drew the second match but won the first and third. Graham Hill won the Monaco Grand Prix, Jackie Stewart the French and the British. John Fairfax completed his transatlantic row, and John Pendleton found the ghost Concorde's flight recorders.

One of his fears had been that he might not be able to read them. But changing the flight data recorder system on an aircraft was what the Navy would term a "dockyard job," a major redesign of key features. There were still many aircraft flying with the original foil recorders, some of the longer production runs with aircraft younger than the instruments they'd been

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built around. At the end of the century, there would still be machines with present-day tape or wire recorders: the ones off this Concorde were the very newest, for Pendleton's time, but they could be read.

It had been at 40,000 feet, climbing, the four Olympus engines running smoothly. They already knew that, though it had meant raising the wings: otherwise they might not have bothered, since Concorde had no flaps or leading edge slats for study and the positions of the main control surfaces were obvious. The nose-cone had been found, having snapped off on impact with the water, and study of the hinges showed that it had been correctly raised to shield the cockpit windows in flight. All the major parts were now in place on the wooden frames, along with many smaller pieces of the framework and skin. It looked as if it had been attacked by metal-eating moths, rather than torn apart and painstakingly reassembled. Nevertheless, since the wheels were up, from many angles it seemed to be skimming low over the hangar floor in ghostly flight. At least with the bodies in cold storage, the most macabre aspect was being avoided: they couldn't be buried legally without a coroner's verdict, and in these circumstances that kind of enquiry was to be avoided at all costs.

As it crossed South Uist the machine had still been travelling below Mach One: it implied that supersonic flight over populated areas had not been licensed, and if he could only make that known, the entire planned series of acceptability tests down the west coast of Britain could be dispensed with. But as to the crash, nothing new was learned: the sudden break in the recording supported the sabotage hypothesis, because a bomb in an aircraft normally cuts off electrical power.

The same applied to the cockpit voice recorder. "The only odd thing," he told Carstairs, "is that overflying air traffic control is from something called Atlantic House, not Redbrae, and there aren't any bearings given on Western Gailes. They *are* using a navigation system called GPS, which is a new one on me."

"And the voice quality?"

"Perfectly clear—as if they're using more channels, in fact."

As the reconstruction continued, the sequence of events became clearer. "Trajectory planning," the technique the AIB had pioneered to reconstruct the breakup of machines in the air from the fall of the debris, was already a very powerful tool (especially since it came into play *after* the flight data recorder ceased to operate): but allied to the new generation of mainframe computers now available, even if they lacked the powers of the one on *Apollo* and the everyday ones on the Concorde, they were not powerful but swift. It was a strange thought that if any of those so-called "typewriters" was what it appeared to be, and had still been working, it might have solved the problem without even the man- and machine-hours of the "new" methods.

Still, brilliant things had been done before such aids were available. In

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the Comet wreckage of 1954, a cabin paint fleck on the wing and an Indian coin embedded in the tail showed that the cabin had ruptured first. The bomb on Comet G-ARCO had been deduced from the examination of just twenty-seven recovered seat cushions: the chief inspector had, by chance, recognised a similarity to a cushion used as a muffler in a safe-breaking incident. In a detailed study by the Royal Armament Research and Development Establishment, the position of the bomb was determined to within half an inch; without computers, at any stage, and without recovering the aircraft from depth.

By comparison, Pendleton had an *embarras de richesse:* the increasing amounts of recovered wreckage, the flight recorders, more material coming to hand by the day. What he didn't have, unfortunately, was explosion traces in the ordinary sense. It was now clear that the aircraft had come apart between the wings, forward of the engine nozzles. The skin had peeled back as far as the fin, and the forepart went into an irretrievable spin as it began to decelerate. But everything located, from either section, made it seem that the missing ribs of the airframe had simply evaporated: a moment there, then gone, with the decompression and the slipstream combining to shred everything in their path before turning back, a fraction of a second later, to attack the people and things forward of the break. Every fragment found embedded in soft material was from the aircraft itself, driven by the hurricane-force of the decompression.

So it wasn't a bomb: more like something science fictional, a disintegrator or a matter-transmitter. The much-delayed commencement of "Star Trek" on the BBC just at this time could scarcely have been less convenient. But whatever had happened out there was outside normal experience, if only for the first fraction of a second. And it was, irremovably, by Act of Parliament, his to investigate.

As the year wore on, the finds of wreckage and bodies petered out. Every so often, however, the beaches would yield another oddity, painstakingly to be added to the vast jigsaw of metal and paperwork. It was unnerving, how much of the aircraft had now taken shape in the reconstruction. Seventy percent of the 1959 Victor had been recovered, in 592,610 pieces, using 40 ships and 1500 men; 80% of the 1954 Comet had been found, using more basic techniques but in more friendly waters. In rough but shallow sea, his retrieval was approaching the same proportions. With each new find, Pendleton would stand down from the readiness rota for a day or a week, however long it took to fit the new piece into place. The rest of the time, plastic sheets were spread over it, as protection from the inevitable leaks in the hangar roof—making it seem like some brand-new, secret prototype, rather than an airliner well through its operational life.

In any other investigation, by now the wreckage would be boxed away, out in the AIB compound, waiting for

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Lloyd's or the Ministry of Defence to decide on its disposal. There was no argument about it, but it was a big problem for the branch to leave it in the hangar, under guard, for what could be a long time indeed.

Otherwise, his training in Air Accident investigation had been resumed, at the beginning, as it had to be. The Concorde investigation had landed in his lap only by chance: perhaps because it was so weird and politically such a hot potato that nobody else wanted it, but ostensibly because of the written rules and the unwritten protocols, nobody ever suggested his removal. He often considered giving it up, knowing how big it already was and how much bigger it was liable to get before it was over; but each time, his personal responsibility, and the face of the girl—a symbol, already, of all the occupants of the aeroplane—kept him from putting pen to paper.

So he worked on light aircraft, then executive aircraft, and single-seat military models—trainers, then combat types he had flown, then the newer marks. He came to know the other distinctive smells of crash sites: not just the ubiquitous kerosine, and sometimes the reek of burning, but the wrongly, wrongly, clean smell of freshly broken pine which came to evoke all crashes, or so he was told. With it, too, came recognition of that "inner sense of elation—a sort of tingling and excitement" when the cause of an accident was found; the charge which the hidden Concorde had still to yield to him.

As an Operations Inspector, he would have to qualify and remain current on at least one large public transport aircraft, plus club and private licenses which he already had. He couldn't start on Concorde, obviously, since it was still in flight testing; but with the intimate knowledge of the aircraft which he now had, even if much of it couldn't be acknowledged on his dossier, he would be in its left-hand seat in due course. He would never have flown at that speed if he had stayed in the Royal Air Force, though if he'd gone into flight testing he might have done some of the things with Lightnings that nobody talked about on the record. Officially, because of the cancelled projects of the '60s, Britain's front-line fighters still couldn't intercept the country's flagship civil airliner.

When he switched on the lights in Hangar T-50, after weeks away from it, the first sight of the reconstruction hanging in its frame always came as a shock. Sometimes it lived in his dreams, trying to tell him the answer in voices he could never quite make out—the pilots, whose voices he knew from the cockpit tape; the girl; or a rasping, mechanical voice of its own.

The guards had been withdrawn from the hangar, to avoid drawing attention to it: on an airfield with restricted access, locked doors, and a sign saying "High voltage—keep out" were an adequate deterrent to curiosity. Pendleton had considered a variety of other official signs, including "Radioactive Material" or "Lasers in Use," with the appropriate symbols,

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or something sinister about protective clothing with a skull-and-crossbones, from the biological warfare establishment at Porton Down; but he wanted the put-off to be as mundane as possible, not even worth mentioning in the pub.

In that, he wasn't entirely successful. In 1972 the *Daily Mirror* ran a front-page story alleging that the RAF had a crashed UFO in Hangar T-50. A live extraterrestrial was supposed to have been seen with the Prime Minister, visiting Her Majesty at Balmoral. Guards had to be posted again, to keep away flying saucer fanatics who were nearer the truth than they realised. The defence correspondent of *The Times* opined that most probably the wreck within was of some classified military hardware, possibly a Remotely Piloted Vehicle for battlefield reconnaissance, and the story gradually faded. At least, from now on, enquiries could be laughed off.

The problem with Concorde G-BOAG, after all, was that it was all too clearly identified; and the government didn't want *that* becoming known. As costs rose to five times the original estimates Tony Benn, now Minister for Technology, was trying to have Concorde scrapped, turned into high-tech jewellery and ashtrays like the components of Blue Streak and TSR2. Pan Am, then the world leader, had turned against the aircraft in 1970, and the other sixteen airlines with options were holding back. A revelation like this was the last thing Benn wanted: it would be overkill, promptly denounced by the opposition as a vastly expensive trick. However, the Conservatives in 1962 had sewn up the agreements far too strongly for cancellation, to make sure the *French* could not back out; there was a prospect of a back-bench rebellion in parliament, with 250,000 jobs at stake at Filton and Toulhouse; so it was convenient to accept the serious warnings by government scientists on the unknowable effects of preventing the accident at this stage.

Instead it was to be forgotten—if it had come from the 1990s, let the 1990s take care of it. Prince Philip took Concorde's controls in May, and in June the plane paced an eclipse of the Sun across Africa. Late in the year, the boards of BOAC and British European Airways were merged into the new British Airways—and President Nixon cancelled the *Apollo* programme, putting two million people out of work and starting a recession which was blamed on the Arabs.

Registration numbers were allocated to the new aircraft. A nice in-joke had been perpetrated: they began with G-BOAA, at once known to aviation correspondents as "Double Alpha," and continued in sequence. So there was a G-BOAC, at last, and would be a BOAG in due course. The first mysteries had been resolved, the jigsaw became a little more complete. But the oil crisis did hurt Concorde: it was becoming clear, now, that the sixteen aircraft taken by British Airways and Air France would be all the orders there were.

For the Accident Investigation Branch, there was plenty of other work on hand. A series of battles had developed with the American Federal

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Aviation Administration over the implementation of safety recommendations. The Paris DC-10 crash killing 346, the worst air accident to date, involved heavy British casualties and brought the issue to a head, while public attention was focussed on the discrepancy in compensation awarded by British and American courts.

In that and other accidents with wide-bodied jets, the loss of life was much greater than in the Concorde—which after all, in a sense, was still to happen. Tenerife, when it came, was worst of all. But in his dreams the shadowy Concorde remained the priority, the girl now the only passenger whose face he could recall. Knowing that she was still unburied in death, not yet conceived in life, he was haunted by her and relations with other women did not succeed. Was he obsessed? he often wondered. Not in a way that impaired his work, at any rate, and the better he was at that, the more likely he was to succeed in the task he had set himself.

In 1977 British Aerospace, too, became a reality, sweeping up not just the British Aircraft Corporation but all the remaining grand names of British aviation: Hawker Siddley, Avro, Vickers, Handley Page, English Electric and even Scottish Aviation Limited, whose initials his friends at Prestwick told him now stood for "Saved At Last."

In the same year, Concorde began passenger services to New York. The development costs had been written off, and British Airways had in the end received its eight aircraft without payment; but the project had cost the taxpayer nine hundred million pounds. In 1981, the parliamentary Industry and Trade Committee called for an end to subsidy of Concorde. Far from scrapping its flagship, the government's response was to allocate another 123 million to operations over the next five years; in that context, even a mention of what was in Hangar T-50 could be construed as an attack on government policy, and Mrs. Thatcher would be having none of *that*, thank you very much.

"... But Mr. Pendleton," said the Prime Minister in deep, earnest tones, as if talking to a child, "what you fail to realise is that Britain must have fully independent capability to destroy the USSR. Whether we will do so, or whether it will destroy itself, is not really relevant. What matters for our prestige and sovereignty is that we *can*. What your Royal Air Force colleagues fail to recognise is that the systems they backed—the V-bombers with Blue Steel, TSR-2, all the British-built, manned forms of deterrent—would have failed to give us sufficient destructive power. Buying Skybolt or the F-111 from the United States were only steps on the way. What successive British governments really wanted was Polaris, because when it is obsolescent Polaris will lead to Trident."

She paused, expectantly, for him to ask the reasons. Pendleton realised that because he was in possession of one major secret, he was being tested on his worthiness to share others. He refused to be drawn: there had been,

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as far as he knew, no update of Harrison's report, which had dismissed the possibility of a UK woman prime minister—as Mrs. Thatcher herself had, around the same time. Pendleton had known she would make it—he had won a bet on it. But he knew, and she didn't, what her political fate was to be. It would be a long run, but it would end long before 1999, and to accomplish what he had to accomplish he couldn't go down with her.

"The point, Mr. Pendleton," she went on, when he said nothing, "is that the national interest involves issues, much bigger issues, than the scientific paradoxes raised by the Concorde wreckage. It is *not* to be discussed, not to be discussed at all."

The rest of the inner Cabinet were nodding emphatically. With Norman Tebbitt, looming at the end of the table, about to approve the AIB's long-delayed office move to Farnborough, it had been quite strongly suggested to Pendleton that these people should not be antagonised unless the integrity of the Branch was at stake.

"Why is the new pound coin called a Thatcher?" asked Neil Kinnock, at the Labour Party Conference. "Because it's thick and brassy, and believes it's a sovereign. . . ." Much more important, to Pendleton, was that another piece of "funny money" had been explained and the Bank of England pound note would be withdrawn. In the same year, on a visit to London, he found in the street an IBM conference folder which the attendee had casually thrown away—including the complimentary scientific calculator inside, not worth retaining. He went to see Carstairs in retirement, and they had a drink on the strength of it.

By the time Thatcher, too, was gone, the Cold War was truly ending. Pendleton found himself called upon to brief the new inner Cabinet, and the investigation took on a new danger: after a government which didn't want to know about the Concorde, and another which ignored it, now there was one which wanted to mine it of information and profit by it.

"I'm against tracing of any kind," he told Maitland, a whizz-kid scientist who'd been assigned to him from Harwell. "Harrison and his people checked passports, driving licences and the rest back in the early '70s. They found some people existed, all much younger, as you'd expect; some they couldn't find, some hadn't been born yet. But the scientists we brought in at that time advised against the whole exercise. The closer we get to 1999, the more visible these people will become. Many of them will be VIP's. In the last year before the crash, the passenger list will start filling up." Now that Concorde was profitable, "from white elephant to golden eagle" with its fan club and its dedicated passengers, seats were booked months in advance and people became irrationally attached to their places, insisting on the same number for every flight. "That information should be kept away from government. If too many people know, find out they or their friends are on the list and cancel the bookings, God knows what will happen. At the very least, there could be

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so many changes that we never figure out what happens."

"What if it's the prime minister of the day?" said Maitland. "Might depend on your politics, I suppose. . . ."

"We do what we're going to do anyway," said Pendleton. *"We prevent it from happening."*

And that made it explicit: the purpose which had directed his life, now for more than twenty years. So often in his work, he had been so close in imagination to those last moments in the cockpit that it seemed he could reach in and tap the pilot on the shoulder. "Wires—you're too low! Go round again!" or "Number Three's going to windmill—feather it now!" But it was never possible: you could only try to make sure it never happened again, whatever it was. Knowing that the interacting complexities of the machines, the sky and the human pilot would be sure to come up with a new one . . . but worse was when you found out, and you issued the warning, and it happened again anyway.

From the cockpit voice recorders, those voices—"We've lost it," from the Turkish DC-10; that German hero, describing everything he was doing to pull out, ending "Well, goodbye, everybody . . ."; from the *Challenger*, that incredibly restrained "Uh-oh"; but most often, sometimes in trepidation, seldom in fear, that final and heartfelt, "Oh, shit." And now, for the first time ever, the chance to prevent one: to intervene at the crucial moment in an accident because in a sense, it hadn't happened yet.

If only—on the day itself, if it came to that—he could figure out what "it" was.

And now at last it was the day: June 30th, 1999, a date which he had been anticipating for thirty years. He had wondered, in the years when he carried the secret almost alone, what would happen if some accident had taken him out before the day arrived. Would the wreckage have been disposed of, or simply sealed up in Hangar T-50, until whatever was about to happen had taken its course? His rise in status in the '90s had at least made sure that there would be preparations—whether they were adequate remained to be seen.

The barriers to promotion had been removed, as Maitland and his team made clear the magnitude of the secret he had kept, and the potential risks if he had allowed the investigation either to be terminated or made public. He had made senior inspector in 1988, after participating in the British Airways strip-down of Concorde "Double Alpha" at Heathrow. That enquiry found the airliners fit to continue flying into the next century. Ironically, Pendleton could have told them that, because the exercise reversed the painstaking re-assembly of G-BOAG nineteen years before. In 1992, part of the rudder was lost at 56,000 feet; two previous incidents had been traced to paint stripper corrosion, but the more rigorous investigation of the third one brought him up to assistant principal. He was a principal inspector now, with thirty years' seniority, and in the run-up to this day he had used all the powers

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which the old chief inspector had conferred on him when he was put in charge of the investigation.

And still he didn't know what he was looking for! That crucial area of cabin, forward of the engine nozzles, was still simply missing, without fragments or chemical traces on the rest to reveal what had happened to it. By ill luck, hardly any of those seats had been pre-booked; for those which had, the occupants had been thoroughly vetted and seemed to be clean. The remaining seats would go to late arrivals, mostly businessmen in a hurry, and were being allocated as boarding passes were handed out at the entrance to the departure lounge. As they were, hidden security cameras scanned them and the National Remote Sensing Centre (also at Farnborough, by good fortune) was profiling and matching them with the dead who had been recovered.

At New Scotland Yard, a similar exercise was matching them against known terrorists and criminals, as fast as could be done with those much more extensive files to search. In the lounge itself, Special Branch and Intelligence officers were mingling with the passengers, marking out each person they *didn't* recognise from the Identikit pictures they had been required to memorise. For Pendleton it was more bizarre to recognise so many, just the ages they had been when fished from the sea thirty years ago. He had to restrain the automatic social impulse to greet them as acquaintances.

The officers had not been briefed on the true nature of the enquiry. The risk of interference with the course of events was too great. With the passing years, Maitland and his colleagues had grown stronger in their warnings of the threat to reality, unless flight BA-002 remained closely in parallel with its past and future counterpart.

But with them knowing so little, the surveillance might be misdirected. They thought they knew what they were looking for, and although they had been briefed to look for *anything* unusual, anything at all, they might miss something vital.

And if they did, or if there was nothing detectable in any case, then after boarding the departure would be placed on hold. Pendleton would phone Downing Street and repeat his earlier recommendation to cancel the flight. As he saw it, his duty was clear. Maitland would then take the phone and, presumably, repeat *his* earlier recommendation that it go ahead, almost certainly sacrificing airliner, passengers, and crew to avoid any risk that causality would be violated.

It would be the prime minister's personal decision. And if it went against him, what then? He knew a Rolls-Royce engineer who had once, as an apprentice, physically stopped a Tristar from departing a Middle East airport because he'd seen the carbon fibre blades of its RB-211 engines being mistreated. It had been only slightly less dramatic than the undercarriage incident in Nevil Shute's *No Highway*. But neither the fictitious hero nor the real one had been surrounded by armed security, ready to

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jump on anyone whose actions were in any way unusual.

Ominously, the Concorde in Hangar T-50 had been briefly delayed. Takeoff was scheduled at 1100 hours, to have the passengers in New York for lunch. The flight plan did indeed cross the Hebrides, going north of the transatlantic great circle route and coming down over Labrador instead of Newfoundland. But travelling subsonically over land, the Concorde would overfly South Uist at 11:50. According to the flight recorders and the watches of the occupants, breakup had been at seven minutes past midday; so takeoff had been delayed about fifteen minutes and presumably would be again.

"Good morning, ladies and gentlemen. British Airways Concorde flight BA-002 to New York is now boarding. Will all passengers with seats in rows one to fourteen please make their way to the departure gate at the end of the lounge. . . ."

"I think we have your men, sir," said a special branch officer at his elbow. "Three Arab gentlemen, travelling in the after part of the Business Section with cabin luggage, just getting up now although their seat numbers haven't been called yet. We've traced their movements in the last few days to Libya, via the Middle East and Germany. It's Lockerbie all over again."

"Go ahead, then. A full search, personal as well as luggage. Apologies if you find nothing, but their flight bags are *not* to be returned to them before they board the aircraft."

Plain-clothes men moved in. "Could you come this way, sir? Just a small query, purely routine . . ." The Arabs seemed puzzled, but went along without objection. Of course, they wouldn't want to attract attention, or might not know what they were carrying.

Could that be all? Could it be so easy? There had been a decline in international terrorism, especially against the airlines. He had been expecting something much more exotic, some lone-wolf inventor, an extraterrestrial or even a time-traveller! Was his lack of reaction just disappointment at something so mundane? On the other hand, he had yet to hear what kind of extraordinary terrorist device this might be.

One way or the other, the "electric thrill" had so far failed to possess him, as the first group of passengers filed into the tunnel leading to the aircraft. The feeling of déjà vu was bizarre: he could sympathise with Maitland's fears that reality itself was under threat.

Just in front of him, three men turned to wave to a colleague. They must have booked very late, to have to be allocated seats in different parts of the aircraft—and that put the other at the back of business class, right in the danger area. Two of these at least he recognised. The man still seated was a stranger; short, with glasses, nondescriptly dressed for a Concorde passenger. As he settled back his briefcase caught on the rim of his seat, revealing that it was fastened to his wrist.

Could it be . . . ? To Pendleton's hyped-up sensibilities, it seemed at

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least possible. Forcing himself to act casually, he walked across, dropping into a seat the boarding colleagues had vacated.

"Excuse me, sir, may I ask you—what are you carrying in that case?"

If the Arabs had been too casual, this was an over-reaction. "What do you mean? What business is that of yours?"

Pendleton showed his identity card—not that this man, with his thick accent (Russian? Ukrainian?) was likely to recognise it. "It's an official matter, sir, just a routine enquiry. Can you tell me what you are carrying?"

"I answered all questions at the check-in!" The man seemed suspicious, rather than alarmed, but his response was decidedly abnormal. "I have nothing further to say."

No, definitely not right. "I'm afraid I must insist, sir. Please come with me."

"I will not—!" But time was running out. Pendleton signalled to two security men, and as the lounge emptied they seized his suspect by the arms, lifting him out of his seat.

As Pendleton rose to follow, he was passed by the girl. She strolled casually through from the bar, smartly dressed in black—no hint of the swirling colours below. Her beauty made everyone else in the room seem drab, and it was doubly startling to see her in motion, as if the corpse he had seen in Lochboisdale so long ago had sprung off the table and into life. And still he had no idea who she was: she wasn't a model or a film star after

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all, for he had never found her in glossy magazines or tabloids, and he had looked often enough.

She looked right through him, and irrationally that was hurtful; as if she could know how she had haunted him, hopelessly, all these years. If she noticed Jack Pendleton, principal inspector, it was as a balding 60-year-old, slightly pot-bellied as a result of his loyalty to traditional beer; probably an airport official, since he wasn't boarding the plane. It wouldn't cross her mind that he could do anything for her, much less the enormous service he was trying to render, on which there was no time even to watch her go.

"This is outrageous!" the man was protesting, as he caught up with him in the side room. "I am Oleg Kerowski of the Russian Academy of Sciences! I demand to join my colleagues on the aircraft, otherwise my government shall hear of this without delay!"

"You're not being abducted, sir, not in the ordinary sense. This is a matter not just of security, more even than national security. It is one of life or death. I must ask you again what is in your case."

"Very well! It is a sample of a crystal material from Phobos, the satellite of Mars, which was returned by our space probe last year."

"By Christ," as a predecessor had said, "this must be it." The feeling of certainty descended on him. "Are you then going to the Case for Mars conference in Boulder, Colorado?"

"Yes—how would you know? The sample has been in Europe for diffraction-pattern study by high-energy particle beam, at CERN. Now I am taking it to the United States, as provided for by the international cooperation on the mission. We have avoided publicity for all this, so that elaborate security precautions would not be necessary. Why do you intervene?"

"There's no time to explain, sir. But under no circumstances can I allow that crystal to go aboard the aircraft. This is Professor Alan Maitland, of Harwell, whom I think you must know by reputation. I hope he can persuade you of our need for your cooperation." Kerowski looked surprised, but appeared to recognise Maitland when he looked at him again.

"I have to disagree with Mr. Pendleton on the wisdom of this course," said Maitland. Seven years on, he had acquired a gravity far removed from his earlier image. "But it seems likely that the particle beam has changed the composition of your sample. If it remains here, we may be able to get some measure of that. I can confirm that if you took the crystal aboard the Concorde all of your lives would be forfeit."

"How could you know that?" said Kerowski. "I will not release the case. I must warn you, there are bio-sensors in the wrist band. Security devices will be activated if it is removed without my authorisation."

"In that case, you may not board the aircraft," Pendleton replied. "I have the powers to insist that you come with us, and when you see the evidence that we have, I hope you

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will change your mind."

Like it or not, Kerowski was escorted from the terminal at a fast pace, the security officers urged on by Pendleton and Maitland. At the side of the building a jet helicopter was waiting, and as arranged the pilot started up as soon as they appeared. Despite their priority, they had to wait briefly for clearance, and as they took off, he noticed with concern that Corcorde G-BOAG had been cleared to taxi.

"The Prime Minister is on the radio, sir." Pendleton had not waited to make the arranged call, and that had to be made good with a link-up through the Heathrow control tower. "I believe we have the answer," Pendleton reported. "Given that, I now agree with Professor Maitland. The flight should go ahead, to keep the sequence of events as closely linked as possible. The danger now is here, not in the air."

"This is all very theatrical," said Kerowski. "Am I to believe that conversation was genuine?"

"When you see what we have to show you, I think you will." As they flew on, Maitland tried to explain. Pendleton had a house in Staines, now: they were crossing the motorway junction on which he was caught in a tailback, four mornings out of five. To the helicopter it was an easy hop. Still, time was slipping away: behind them, G-BOAG was already in the air.

It was a still day, slightly misty, as if nature itself was waiting for the mystery to be resolved. As they came in over Farnborough's famous Black Sheds, Pendleton was reminded of his first day here and the history of the place. One way or another, in a few minutes it would alter again.

They landed by the AAIB headquarters, the rotors still turning as they left the machine. This too was prearranged: it wasn't likely there would be time to get away, if things went badly wrong, but the pilot had volunteered. Another brisk march followed, over to Hangar T-50 and the waiting wreck of the airliner, still poised as if in flight like its counterpart, now nearing the Borders.

Kerowski had stopped in his tracks, then stepped forward to stare at the aircraft from a different angle. "It's impressive, but you could have staged it."

"What—all of this, just to get you to let go of that case? Besides, even a brief inspection will show you the airstream and water damage. We couldn't have lost a real Concorde and kept that secret."

That got a sad nod. "We lost our SST in 1973, at the Paris Air Show. I had a part in the calculations for that project—"

"One more thing may convince you, sir. Please come this way—there's very little time." He led the Russian across the hangar floor, towards the crucial anomaly—the lettering, below the cockpit windows, which fortunately had survived the detachment of the nose cone. "We have followed the counterpart of this aircraft through its history, through construction and testing, into service, waiting for the flight in which all the details matched. Between this air-

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craft, and the one in the air, this is the only point of difference."

"I see nothing significant," said Kerowski.

"It's the name, sir. Concorde doesn't have its name on it, because all the world knows what it is. Yet it would have had, but for a political gesture.

"The original plan was for the Concordes completed in France to have the final 'e,' while those finished here would be 'Concord,' as you see it. It was Tony Benn, afterwards an opponent of the project, who announced the change in 1967. At the roll-out of Sud-Aviation's prototype he announced that all Concordes would have the final 'e,' to stand for entente, excellence and England."

He had Kerowski's full attention, but still he hadn't conveyed his point. "*This isn't our Concorde.* It's from a different universe, one differing from ours only by a government minister's decision on the name of an aircraft. Somehow your crystal linked those universes, pushing this 'Concord' into ours and thirty years into the past. It doesn't belong here, and we have to send it back."

"You have a poetic way of putting things, Mr. Pendleton," said Kerowski. "You should have been a physicist." With that, he drew out a pen, touched its point to the bracelet at several points, and handed Pendleton the case as it came free from his wrist.

"Thank you, sir—good God!" He had looked at his watch—digital, of course!—and found its reading frighteningly close to the one on all those other watches, inside. "Get him out of here! Either the control room or the chopper—but you two get in the chopper and get out altogether."

He strode down the aircraft, up the ladder and along the wing. Ducking in through the breach in the fuselage, he was confronted by the evidence he hadn't had to show. The recovered bodies were back in their seats, the last of them matched up with the boarding list relayed from Heathrow; thawing out, after thirty years, but still with a glossy sheen of frost. He couldn't have shown Kerowski his own body, blown to bits, presumably, in the other universe, but his colleagues were here.

Most bodies had major injuries; some had been days or weeks in the water before being picked up; some had been subjected to post-mortem dissection. Viewed one by one, in the antiseptic chill of the mortuary, they could be treated with professional detachment. Collectively, here, they made a scene from a horror movie.

He forced himself not to look towards the girl's place, as he matched up Kerowski's seat number and fastened the briefcase to the frame. Better, far better to remember her as he had seen her minutes ago, remote but wholly alive. At least now the crystal was here with the wreck, and not with those people up there.

At the side door, despite the need to get clear, he paused for a last look. This time, the lights had to stay on, but there was no reason to believe he would ever see his reconstruction again. He closed the door, and walked briskly to the Admin block; it would be undignified to run.

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Kerowski had opted for the control room, and was there with Maitland. Screens showed the wreckage from every possible angle, and in many different frequencies: proximity to the Remote Sensing Centre had again been an advantage. "Have you evacuated everyone else?" the Russian asked.

"We don't know how much energy will be channelled through the crystal at the crucial moment," said Pendleton. "If it's $E = mc^2$, for the whole mass of the aircraft, then we should have evacuated most of western Europe! It'll be one hell of a bang. There was talk of getting the wreckage off the Earth's surface, but we can't orbit a whole airliner even today. We might have asked you to do it with an Energia, if we melted it or crushed it and sent it up in blocks, but then the identity question would have arisen—it's the organisation of the matter which characterises it as the plane and creates the paradox."

"It may not be as violent as that," said Maitland. "To resolve the paradox, the molecular structure may disintegrate but not the atoms. Or the aircraft may just drop through a 'wormhole' into the alternate universe, where the crystal simply exploded."

"And you're here to see," said Kerowski, admiringly. "It could all have been done by remote, but something crucial might be missed. And you could not delegate the risk to a junior man. Science does this to us sometimes, does it not?"

Pendleton put a hand on Maitland's shoulder. "If he doesn't get a Nobel Prize out of this, he may get a best-seller to rival *A Brief History of Time*."

"There's a Tornado from Leuchars following the Concorde, as arranged," said Maitland. "The pilot's reported nothing strange, so far."

"Repeat the instruction to keep a distance," said Pendleton. "If we're all wrong about what's going to happen next, we don't want more than one aircraft loss."

Time. One moment the wreckage was on screen; the next, gone. There was an impression that the case containing the crystal had fluoresced. A hundred tons of metal, plastic, and thawing flesh disappeared, back to a world which in that moment was launched on to a more different track of history. There was an implosion like a thunderclap as air filled the vacuum; dust swirled up, the walls caved in, the roof came down, and the screens went dark. From outside the sound continued as the hangar collapsed.

Pendleton picked up the microphone with a slightly shaky hand. "Zebra One, report on the status of Bravo Oscar Alpha George, over."

Maitland switched on the speaker. "Zebra One to RAE: no change. But I could swear there's something wrong with this visor, or my eyes: for a moment there I'm sure I saw two aircraft. Over."

"Roger, Zebra One. Thank you for your assistance. Terminate your observation and return to base, out."

And now it was really over. In that other world, Concord G-BOAG had just disappeared from the radar in At-

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lantic House, the international air traffic control centre which had replaced Redbrae. There would be a scatter of debris on screen, but there had been no distress call and there would be no alarm, for a moment. "Oscar Alpha George, do you read?" High in *that* Hebridean sky, those people were already dead, killed by the explosion, the decompression or the transonic slipstream. That girl's face was frozen now in that angelic look of calm which had haunted him, here, for so many years, showing that she died with courage. In this building's equivalent, in a few minutes, the phone on his desk would ring.

In this reality, she might be leafing through the in-flight magazine, or accepting champagne now that the airliner had passed the speed of sound. Out over the Atlantic the Concorde was carrying her on to her appointments and contacts in a social world he could never approach, as remote from him as the planet Mars or that other dimension into which her dead body had gone. Her life had crossed with his in real-time for just a few short minutes, when they shared the Heathrow lounge. That it *was* carrying her on, and all the other passengers who had been snatched from death there, would be his only reward.

For these two with him, it might be different. Vast amounts of data had been recorded by Maitland's computers, and he was making sure it had all been copied to the backups in the Atomic Energy Establishment. "It's over to you, now," Pendleton said to Kerowski. "You can tell him what there is to know about that damned rock. Maybe when you get together with his boys, you'll come up with time travel or some similar breakthrough. I'm content with what I've achieved: there's a planeload of people up there, and yourself down here, who would otherwise be dead. Preventing that has been my ambition for all these years. With every accident I've wanted to reach back in time, tell the pilot, stop the baggage handler, somehow prevent it from happening . . . and just this once, I've been able to do it."

"For the other universe, the consequences are terrible," said the Russian.

"Yes, you're right. Over there the emergency alert has begun, the air-sea rescue organisation is being mobilised. They know where it went off the radar, and eyewitness reports will be coming in. Over there, maybe, another version of me will be packing his bags for a dash to the Hebrides, as I did in 1969. He'll have it all to do—the recovery, the reconstruction—though he'll have all the appropriate information. The flight recorders won't contain any mysteries, and he'll not have to do so much detective work on the people. But he'll be working in the glare of the media, the relatives' grief, recriminations, lawsuits. . . . I'm not sorry to be missing all that."

"You could have saved him all that, and saved their lives in both universes, by not putting the crystal in the wreck!"

"No, you're wrong there. Then it wouldn't have come here, we

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wouldn't have been forewarned, and the Concorde in this Universe would have crashed, and I would have it all to do now. I've done all that could be done, and it can't be taken from me."

"And if I hadn't given you the crystal?"

Pendleton had given serious thought to requisitioning a gun, having no idea what he would face today, but in the end had settled for a pair of handcuffs. He showed them to Kerowski. "If necessary, I'd have chained *you* to the frame. And stood guard by the wreck to the end, in case you got free."

As usual, he avoided the motorway going home, and as usual, pulled into the pub yard at Virginia Water. His ritual pint of Real Ale had seldom been better deserved. As he nursed it, he kept an eye on the TV above the bar. If his achievement attracted any media attention, it could only be now.

"... In Farnborough and Fleet, Hampshire, today, windows were rattled by a mysterious explosion which caused many calls to emergency services. Later a Ministry of Defence spokesman stated that an obsolete hangar had been demolished in a controlled explosion. No personnel were injured and the Ministry wished to apologise for any inconvenience or alarm which had been caused. Peter Blow has more details."

The picture cut to a helicopter view of the airfield. "Today's demolition at Farnborough was evidently of Hangar T-50 in the Accident Investigation section, made notorious in the 1970s by allegations that the British government used it to conceal a crashed UFO. At Farnborough today, an Air Accident Investigation officer who declined to be named said, as he left the Royal Aerospace Establishment, 'If anything ever was there, I can assure you that it's not there now....'" ■

If you want the rainbow, you gotta put up with the rain.

Dolly Parton

If only we'd stop trying to be happy, we could have a pretty good time.

Edith Wharton

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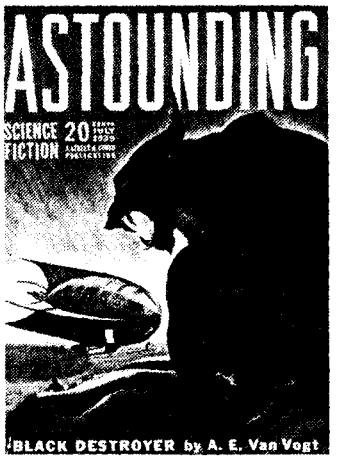

Critics mark this issue as the first "great" issue edited by John W. Campbell, Jr. It contains the first published story, "Black Destroyer," by A.E. van Vogt and the first story by Isaac Asimov to be published in **ASTOUNDING.**

This hardbound facsimile of the July 1939 issue also contains an Epilogue in which A.E. van Vogt, Asimov, and Rocklynne comment on their own work, their feelings towards **ASTOUNDING**, and especially their relationships with John W. Campbell, Jr.

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A Deeper Sea, Alexander Jablokov, Avon, $22, 360 pp. (ISBN:0-688-11113-0).
Correspondence, Sue Thomas, Overlook Press (149 Wooster Road, New York, NY 10012), $19.95, 155 pp. (ISBN:0-87951-480-9).
Crystal Line, Anne McCaffrey, Ballantine/Del Rey, $20, 295 pp. (ISBN:0-345-37984-5).
Retro Lives, Lee Grimes, Avon, $4.50, 196 pp. (ISBN:0-380-76913-1).
Mostly Harmless, Douglas Adams, Harmony Books (Crown), $20, 277 pp. (ISBN:0-517-57740-2).
Unmasking, Nina Kiriki Hoffman, Axolotl Press (Pulphouse Publishing, Inc., Box 1227, Eugene, OR 97440), $10 tp, 103 pp. (ISBN: 1-56146-123-7).
Is Anyone Out There? Frank Drake and Dava Sobel, Delacorte Press, $22, 272 + xvi pp. (ISBN:0-385-30532-X).
Full Spectrum 4, Lou Aronica, Amy Stout, and Betsy Mitchell, eds., Bantam, $12.95, 487 pp. (ISBN:0-553-37142-8).
Books on Disk

Alexander Jablokov's **A Deeper Sea** is one of those science fiction stories that many authors develop as they attempt to justify a single powerful, dramatic, or just plain nifty image. I don't know whether this was the way Jablokov worked—I haven't asked him—but assuming he did gives me a handy way to shape my review.

The image here is that of a sperm whale diving into the atmosphere of Jupiter. To get there requires answers to such questions as:

"What's Moby thar wearing for a space suit?"

"Since whales don't have hands or technology, humans must have built the suit and carried Moby to Jupiter. Why?"

"Obviously, the whales must have done a bit of persuading. But they don't talk. But dolphins and orcas are smart enough, though the research on their language abilities has fizzled. So how come they're talking here?"

"You say they used to, once upon a time? Until that volcano blew Crete and the Minoans away? Now someone just goosed them back into yakking?"

"Well, okay. But humans have long

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dreamed of using dolphins in war in the sea, not taking them to space. So how do you get there from here?"

Meet Ilya Stasov, a researcher into cetacean communication in Vladivostok. He is visited by Georgios Theodoros, another researcher who has been paying attention to ancient myths and suspecting that there was a time when cetaceans did talk to humans. For some reason they stopped, and the time seems indeed to coincide with the end of the Minoan civilization. "Aha," says Stasov as he rigs his sound generators to repeat the sonic image of that eruption, and suddenly the dolphin Kestrel screams in perfect Russian, "Let me die!"

Now indeed the military takes over. Talking dolphins become agents of destruction in a war that pits Russia against an alliance of Japan and America (in which Japan dominates). Stasov winds up in a prison camp while the dolphins and orcas use their reactivated speech to wheel and deal, to talk of a cetacean God, to appoint a delphine John the Baptist, to announce a delphine Messiah, and to become interpreters of signals recorded from intelligent beings living in the atmosphere of Jupiter. Stasov returns to research, and one day a horde of dolphins hounds a sperm whale into leaping out of the sea onto a rocky island. Stasov rescues the mortally damaged creature and hopes to save his life. But then the cetaceans announce that this whale should go to Jupiter, as a cyborg, a singing ship of quite a different kind than that Anne McCaffrey made famous.

There is more, of course, and it all takes many years. Stasov has an intermittent love affair with Anna Calderone, another researcher. There is the interplay of past and present, myth and reality, religion and science. There is guilt over the exploitation of "animals" both in the lab and in war. There is a large amount of superlative writing—Jablokov is superb at creating worlds that have all the texture and persuasiveness of life itself. And there is a cheeky audacity that says, "Don't bother me with complaints about plausibility."

He needn't have worried. The reader bridles only briefly at the notion of dolphins that speak Russian without learning the language, and when the story first broaches the notion of whales in space, the idea almost seems reasonable. Jablokov carries off the justification of his image with remarkable success.

Sue Thomas's **Correspondence** made something of a splash when it was published in England. Now it's available as the second in Overlook's line of feminist SF novels (following Rachel Pollack's *Unquenchable Fire*).

The author "is professor of a feminist science fiction workshop in England as well as fiction editor of *Mosaic* magazine." The novel has, says the publisher's puff sheet, "been described as a mix of cyberpunk and magical realism . . . hailed as 'A complex and confident first novel . . . Cheerfully subversive.' "

The only trace of cyberpunk —which in fact is no trace at all— is that its center is a woman who, to diminish her personal pain, is having

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herself replaced by bionic parts, even unto her nervous system. She may not even be real, for though Thomas presents her as the "compositor" of fantasies for consumption by people who plug into a kind of virtual reality, she may actually be no more than a character in such a fantasy. The characters she creates—Rosa, with Shirley forcing herself in willy-nilly—are more definitely imaginary, as well as trite. Those who represent the reader (the consumer of the fantasy) are less so, while the one that pretends to be a tour director—warning the reader not to get too involved or to try to rewrite the story—seems to be more like a software utility.

Software? Well, yes. The whole thing pretends to be a virtual reality computer game whose characters the user can become. Is this another trace of cyberpunk? No, for cyberpunk is at least as much a mood as it is a sfnal technology.

Well, what about the claim for magical realism? It could be made only by someone who hasn't the vaguest notion of what virtual reality is. But what about the way Anna seems to take on a life of her own and invade the computer that is in the end the compositor's brain? That can be seen only as blatant metaphor for the way authors become obsessed with the characters they create. And besides, the compositor herself is only a character, an element in the software.

Is metaphor the key? Of course. *Correspondence* is rife with metaphors for writers and readers, writers who personify and identify with their typewriters or word processors, characters and children and other creations, women and their need to assert their existences. And if the whole thing is a bit confusing, so is life.

Some people will love it. As in England, they will call it an ambitious, challenging work of undoubted literature. Some others will say that it seems rather deliberately literary and is therefore pretentiously self-conscious. I lean toward the latter view myself, though I have to admit that Thomas makes a difficult story concept work surprisingly well.

Most *Analog* readers, I think, will prefer to spend their money on something else.

On Ballybran grow immensely useful (and therefore valuable) crystals of many colors. To find them, you sing a pure note. They answer, and then you cut them from their stony matrix. The work demands miners with musical talent, including perfect pitch, and the world traps them with a demanding symbiote that confers health and long life yet refuses to let its hosts leave Ballybran for long. The miners also lose their memories, and they can be killed by Ballybran's storms, which awaken sonic storms and bring mountainsides crashing down.

This is what Anne McCaffrey gave us when she introduced crystal miner Killashandra Ree in *Crystal Singer* some years ago. Later she extended the story in *Killashandra*. Now she gives us **Crystal Line** and tries to solve some of Killashandra's

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problems.

The miners' intimacy with crystal makes Killashandra and her partner Lars natural choices as investigators into a barren world whose caverns contain strange crystal formations that seem to grow and may be sentient. At least, they eat and grow and emit electromagnetic signals. Yet the brain-ship that brought Killashandra and Lars on their mission proves unable to see the crystals in their caves.

Upon their return to Ballybran, they find the chief of the Heptite Guild, Lanzecki, their boss, apparently bent on monopolizing their time. Killashandra craves the mountains and abandons base and Lars. Lanzecki proves suicidal and Lars is his designated successor. Killashandra forgets, grows enraged when Lars proposes to change the traditions of the crystal singers by (among other things) introducing memory recovery techniques. That is, she—like most of her fellows—is a heck of a prima donna.

Estrangement is total until those strange crystals reenter the tale. Researchers wish to plant Ballybran crystals in the formations. Killashandra goes with them, and events conspire to restore her memory and return her to Lars' side to save the Guild and march gloriously into the future.

Despite its predictability, the book will surely appeal to a great many readers. McCaffrey has long shown a remarkable market appeal. What's more, she exerts that appeal without the conanism so popular in the field. On the other hand, she does get rather mawkish, consistency sometimes suffers (that brain ship seems to have no trouble seeing the crystals on the second visit), and plot gimmicks often seem to demand that the characters be peculiarly boneheaded idiots.

Lee Grimes's **Retro Lives** begins with an intriguing premise: Robert Widdick, born in 1890, lived a normal life until 1950. At age 60, however, he began to develop a curious progressive amnesia. Day by day, his memory crept backward in time. By 1960, he could remember nothing after 1940. By 1970, he could remember nothing after 1930. By 1985, he could remember nothing after 1915. At this point, he became able to accumulate memories again.

It turned out that Widdick had a strange new gene on his Y (male) chromosome. This R-factor gene dictated that at a certain point, he would "unwind" his life and start over. The obvious unfortunate side effect is the loss of memory. Less obvious but more unfortunate is that he must always start over at the same point, age 25, 1915; that is, he will be ever more crashingly out of date if his condition persists into the 2100s, 2200s, 2300s, etc.

Grimes posed his situation in such a way that I was really quite eager to see what he did with it all. Sadly, I did not remain so eager. *Retro Lives* turned out to be little more than a very nice background piece for the novel Grimes did not write.

Grimes does not give much of a feel for life in future centuries, but he is quite meticulously logical in work-

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ing out the necessary genetics of the situation, the way the gene might come to be attached to X chromosomes too and thus give women the same curse or gift, and even of how the R-factor might affect a child who received a double dose, one from each parent. He recognizes the Widdick clan's need for secrecy and protection, the likelihood that some member of the clan might decide the R-factor had come from the Devil, become a fire-and-brimstone preacher, and rouse the rabble, and the necessity that the clan find some way to fit into the larger society. Alas, that is about it. What people-based plot there is—mostly centering on that preacher—just was not developed enough.

Mostly Harmless, the fifth volume in Douglas Adams's Galactic Hitchhiker series, is indeed mostly harmless. Unless you happen to be an Earthling.

Adams has trashed the place before, but fortunately the multiverse contains such a very large number of alternate Earths that those who can see everything at once, without filters, see the place as rather like a blue and green sausage. That is, there's room for lots more trashings and volumes in the series. Or is there?

This one begins with a shipful of Grebulons who, because their ship has been damaged, haven't the vaguest notion of where they're from, who they are, or what they're supposed to be doing other than monitor something or other. So they find a planet and settle in to monitor it. The next element of the WSOGMM (Whole Sort of General Mish Mash) is Tricia McMillan, a British TV journalist with degrees in math and astronomy (she abandoned that career when she met a two-headed space alien who wore a birdcage over one head so as not to attract attention). She is in New York to interview an astrologer and try out for a network anchor slot when the Grebulons kidnap her. Meanwhile Ford Prefect is discovering an alien takeover of the *Hitchhiker's Guide to the Galaxy* outfit and a new model Guide that has the ability to see everything, including a sausage-Earth. (Poor us—we never sausage a place.) As he escapes, he mails the new Guide to Arthur Dent, resident Sandwich Maker on the isolated, barbaric world of Lamuella, which is not too isolated to hide him from an alternate Tricia called Trillian who wishes to introduce to Arthur the daughter he sired on her (thanks to a sperm bank far distant in time, space, and probability) and—just in passing—drop the obnoxious brat off. The kid, Random, promptly opens Ford Prefect's package, discovers that this Guide is able to arrange rides and the like simply by seeing everything and selecting alternate realities in which desired events have already happened. Probability is meaningless, and Adams owes Mike Resnick an acknowledgement.

Now bear in mind that the hostile takeover of the Guide is by Vogons, those nasty villains who wish nothing more than to destroy the Earth. This new, supernally manipulative Guide is their creation. Everything that has ever happened has been selected to-

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ward one fearful end. The situation is hopeless.

Or is it? Adams never quite clarifies what happens at the end. I presume he wishes to leave his options open for volume six.

Do you want to buy it? Well, if you enjoyed previous volumes in the series, you can't help yourself. It's a hit of bubbly seltzer in a dour, dour world. If you hated your last sample or if you're pretty dour yourself, forget it. If you've never heard of Adams or the Hitchhiker series, give it a try. Adams's cockeyed logic is bound to make you smile.

Nina Kiriki Hoffman's novella, **Unmasking,** is a beautifully executed story that I found impossible to believe. The least of my reasons is that even though the tale has a strong SF component, its chief character is a common-sensical bag lady who talks to the cardboard box in which she lives, to mall doors, to about-to-explode-in-flames wrecked cars, and to houses in a way that must make ordinary people say, "She's nuts!" On the other hand, she does get answers —indeed, doors even unlock themselves when she says "Please."

So is this one really fantasy? Bag-lady Matilda (Matt) Blackaver wakes up one morning, crawls out of her crumbling box, and sees that the world is suddenly even nuttier than it thought she was. People are finding long-repressed memories bursting to the forefront of their minds—memories of things they have done, memories of things done to them—and they cannot cope. They murder. They commit suicide. Chaos rules.

Why is all this happening? Hoffman shows us a mad scientist. He has discovered an enzyme that will unleash buried memories. In order to make everyone whole and potent, he has dumped it in the water supply. This gimmick makes the fantasy into SF, even though Hoffman seems to be saying that if, like Matt, you don't repress your nastiest memories (she can't go nuts because she's already nuts, right?), you do indeed gain immense and strange powers.

Matt now becomes the rock of sane stability for a woman she meets at the mall, her infant in a stroller, her husband waiting sleepily at home; they are untouched because they drink only bottled water. The tale becomes a warm lesson in seeing past stereotypes, in tolerance and understanding, very enjoyable, a pleasure to read, and the question of whether it is fantasy or SF becomes irrelevant.

If we must have a label, magic realism may be the best choice. Yet saying so makes it no easier for me to suspend my disbelief in the face of Hoffman's claim that *most* (not just some, or even many, but most) people have memories whose release can lead to such utter chaos. That's just too much of a stretch for me, even though I often call myself a cynic.

When I was in college and graduate school back in the sixties and early seventies, the business of listening to the radio whispers of the stars and hoping to pick up signals emanating from some alien civilization was still new. As a science fiction fan, *Analog*

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reader, and biologist, I was enchanted. I was as in love with SETI (Search for Extraterrestrial Intelligence) as I was with the Apollo program. I read Shklovsky's and Sagan's *Intelligent Life in the Universe* and later Bracewell's *Galactic Club*. In my youthful arrogance, I thought the Drake Equation, which estimates the number of alien civilizations available for contact, rather obvious. Yet I also thought Frank Drake one of the few scientists with a vision equal to his calling. I almost held my breath waiting for word of success from Green Bank or Arecibo.

That word, of course, never came. On the other hand, Frank Drake now tells us with the aid of science writer Dava Sobel in his biographical memoir, **Is Anyone Out There?** that there have actually been a fairly large number of tantalizing signals that lasted too brief a time to be checked out and analyzed in detail. Drake feels, he says, that the long-sought aliens may be scanning the cosmos so that the beam of their message never lingers. Or perhaps we are immersed in a sea of signals that only briefly rise above the threshold of audibility—we stand in a room full of strangers, catching a word here and there, and we know that if we could get their attention, if they would aim their speech at us, if our ears were better, we would hear wonders.

In *Is Anyone Out There?* Drake tells how he first began to think of alien civilizations when the merest child, exposed to Sunday School teachers from the University of Chicago's Oriental Institute. He also learned to keep his mouth shut until 1951, when he first heard others talking of such things. The occasion was Otto Struve's visit to Cornell to lecture. Soon thereafter, Drake was setting up the radio telescope at Green Bank in West Virginia and using it to scan a pitifully small range of sky and frequency—at least compared to what is possible today, as radio astronomers hook to their dishes electronics packages capable of scanning millions of channels simultaneously. This is the part of the story with which he ends, when technology has made possible the duplication of Drake's entire Project Ozma in a fraction of a second and the SETI dream has survived little funding, Proxmirean ridicule, and years of disappointment to flower in a grand new effort. Perhaps now, he says, we will at last make contact.

I hope so. So do you, or you would not be reading this magazine.

What's more, you will surely love Drake's and Sobel's account of the quest. Buy this one, and use what you learn to encourage the dream in others.

At present, the premier original anthology series seems to be **Full Spectrum,** now in its fourth fat (twenty stories) volume. Editors Lou Aronica, Amy Stout, and Betsy Mitchell have done a fine job of picking fiction that impresses both readers and other writers. According to the jacket copy, the first three volumes won ten Hugo and Nebula nominations. Perhaps it is unfortunate that the same blurb admits that the first volume garnered the lion's share of those award nomi-

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nations, for this fact permits skeptical readers to play a numbers game that suggests decline.

Could that possibly be true? Could *Full Spectrum* be fading? The answer surely depends on your viewpoint. The editors have sought from the beginning stories of high literary ambition. Those nominations indicate a satisfying degree of success, and I think this volume will surely garner a few more. Martha Soukup's "The Story So Far," in which two women characters in a story struggle to achieve some independence of the dominant male's plotline and even devise a story of their own, comes to mind as a possibility. So does Danith McPherson's "Roar at the Heart of the World," in which an African tribe uses its magic—and that of a white girl with the ability to hear and speak to animals—to seal off a bit of their world against the destructive insanity of war. Kevin J. Anderson's "Human, Martian—One, Two, Three" is perhaps too sentimental a treatment of bioengineering and obsolescence but some will love it. David Brin's "What Continues, What Fails" works rather better in its considerations of personal and cosmic survival of the fittest.

Some others also warrant praise, but there were a number that struck me as so deliberately "literary" —meaning that they seem to be struggling to imitate stories that have garnered praise in the past—that they succeeded only in their opaque pretentiousness. The single worst offender was Del Stone, Jr.'s "The Googleplex Comes and Goes," in which a bizarre alien construction appears in a small city, does a modicum of damage, and vanishes, but there were enough more such stories to make the volume as a whole a struggle to finish.

Sadly, I find an appalling amount of pretention elsewhere as well. I can therefore say that if *Full Spectrum* is declining, that decline may be as much a symptom of a general fear of originality as it is a weakness of the series, the publisher, or the editors.

BOOKS ON DISK

John Galuszka recently sent me a copy of the tenth issue of his *Electronic Publishing Forum*. As usual, it consists of new product announcements, commentary on the disk-top publishing field, and a bigger and better "Electronic Books in Print" feature, which allows "hypertext navigation through the database, cross-referencing by title, author, book category, and subject matter, plus extensive excerpts. 'Electronic Books in Print' will be an annual publication available from Serendipity Systems [P.O. Box 140, San Simeon, CA 93452] for $6.00 postpaid to North American addresses, or $8.00 overseas." *EPF #10* also includes "Cozy Reader," a new shareware file-display program, similar in several ways to Ted Husted's DART, and "Orpheus," a shareware hypertext authoring and reading package for MS-DOS computers, created by Canadian poet Rod Willmot.

"Cozy" works well, making fewer claims than DART and living up to them adequately. However, I cannot

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say as much for "Orpheus." This program looks very attractive, especially when it claims to be able to present graphic and text screens on the same basis—meaning with the abilities to incorporate hot-buttons to leap to other screens and to back out at will to previous screens. When I tried it out, it seemed to work quite beautifully—but only as long as the material it was dealing with was pure text. When I summoned the demo graphic into view, the program froze up. The only way to get out of the graphic was to use a "map" mode of navigation through the array of hyper cards, and after a few uses of the map, its labels proved unstable. Not recommended, at least in its 1.21 incarnation.

I find it unfortunate that as long as the electronic publishing market is dominated by the electronic version of the small press, as long as the big software houses see it as small potatoes, it does not seem that we will see anything that works as slick as it looks. Certainly I have not yet seen any disk-top display program that didn't have some problems, although some—such as Serendipity's own program—have improved considerably since I first saw them. ■

Only our familiarity with war makes it intelligible that a state of warfare should alternate with a state of peace in one tribe's dealings with another. The idea is quite common over the world, of course. But on the one hand it is impossible for certain peoples to conceive the possibility of a state of peace, which in their notion would be equivalent to admitting enemy tribes to the category of human beings, which by definition they are not even though the excluded tribe may be of their own race and culture. On the other hand, it may be just as impossible for a people to conceive of the possibility of a state of war.

Ruth Benedict

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BRASS TACKS

Dear Mr. Schmidt:

I know you will not lack for responses to your editorial, "Evolution and Ethics" (January 1993), but as somewhat of a cultural spotted owl myself, I couldn't resist a hoot or two of my own.

I was born in Amsterdam, the Netherlands, and came to this country at five years of age. As a transplanted Dutchman I find much of what you said about languages and cultures easy to agree with. That I still know the Dutch language is a tribute to my mother's strength and tenacious loyalty to our mother tongue, and I'm very grateful to her. Knowing another language, I can readily agree with those who contend that when people lose their language, their culture is doomed. For me, the Dutch language gives a unique expression and view of reality English cannot. I would consider it a real loss if the language of my ancestors went the way of Tyrannosaurus.

But I live in America now. My success here is due in large part to my ability to function in this culture, and speaking the language is the key. I have to thank my parents for setting a good example and promptly learning the language of our adopted home. They were helped by their practical, realistic cultural heritage.

Dutch is a small, minority language, spoken by people of a tiny country, surrounded by language superpowers—German, French and English. In recognition of their situation, the Dutch teach their children these three languages in the public schools. And though they are adaptable, these pragmatic, hardworking flatlanders will not let their language or culture completely disappear. I'm not worried about that.

But in my own immediate family my Dutch culture may very well end with my brother and me. To kindle and keep it alive in our US-born children by "heroic measures" seems a melancholy and fruitless effort. This little bit of transplanted Dutch culture may just die out naturally. I agree that species, or cultures, should be allowed to do that when no longer viable. Of course the true test of viability is the successful efforts of the members to survive reasonable environmental stresses. Aggressive persecution by the majority culture is of questionable value as an indicator of viability.

What I strongly disagree with, and resist completely, is the monoculture, whether biological or cultural. As you say, while a biological monoculture may feed more humans, the

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world would lose so much beauty that only a colossal racial conceit could possibly judge the results worthwhile.

But there's *danger* in the monoculture as well. It would be suicidal, for example, to reduce the world's grain production to a single genetic strain of wheat. The loss of genetic diversity would leave billions of us vulnerable to worldwide famine, should our monoculture grain be without resistance to some new disease or pest. Social monocultures would leave us similarly vulnerable. With only one way of seeing reality we would soon be caught in a famine of ideas, bankrupt for new approaches to new problems.

But beyond this point we differ. I do not agree that someday we will, or should be able to, formulate better general principles for balancing our efforts to save species and cultures vs. the need to let evolution take out the occasional non-viable unfortunate and make room. You see, I don't trust anyone to make those choices. Based on past performance, I mistrust man's greed, avarice and arrogance as much as his ignorance, folly and sloth.

Furthermore, I don't believe we ought to play any role in the choosing, except to just stay away. Human choices will almost certainly be wrong. Except possibly one, which is almost the same as one you ruled out as unrealistic. That is, to choose to never hurt or *cause* anything to die. True, this has it's own difficulties in the application, but it has the advantage of removing man from the role of God. It has worked for two thousand years for the Jainists of India, with surprising side benefits.

To return to the spotted owls, it's important to see that it is not heroic efforts to save owls, but heroic measures to kill habitats that is really at issue here. With all our concern over owls and loggers, the true victims in all this get forgotten—the trees! It is the height of racial conceit to claim that satisfying our own out of control craving for wood and paper is more important than nature's diversity. If we stopped our extraordinary efforts to kill the forests, the spotted owls (and other possibly valuable species) would have a fair chance of demonstrating their viability.

We need to learn that we are not wise enough to be instruments of extinction. We'd all do well to learn to tread more lightly on this planet—to learn and practice the hiker's creed to take only pictures and leave only footprints.

Perhaps, on some proximate future day when we must choose between wood products or permission to have a baby, these questions will come into sharper focus.

Best Regards and Gelukkig Nieuwjaar

(Tot ziens en Happy New Year)

JOHN VESTER

Rancho Cordova, CA

Dear Mr. Schmidt:

I have just read your editorial in the January issue. I am employed in the timber industry so your comments regarding the spotted owl naturally attracted my attention. When the issue of the spotted owl first surfaced in 1990, it was stated that only

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30 pairs of these birds existed and that they could only survive in Old Growth forests. Further, we were told that draconian measures were needed to assure the survival of the species. These measures would mean the loss of thousands of jobs in the Pacific Northwest, an area that had already lost tens of thousands of jobs since 1982. Today more than 300 pairs of these birds are known to exist, more seem to be found every day. Interestingly, at least 100 pairs are known to exist in New Growth forests, here defined as forests with trees that are less than a century old. From the foregoing it would appear that the research behind the original statement of 30 pairs was appallingly bad or we were deliberately lied to. Further, so far as I know as of this writing, no research has been done to determine if the Northern spotted owl is a genuinely unique species or whether it is just a variation of the California spotted owl. The real issue here is Old Growth forests and what we as a society are willing to pay for the preservation of same. Costs are rarely mentioned by environmental groups, yet are an integral part of the debate. The Pacific Northwest produces 40% of lumber in the US. Reducing this output significantly will obviously drive up lumber prices and the cost of new homes. Nor will the remodeling and furniture markets be unaffected. What we really should be looking at is how many jobs we are willing to sacrifice and how much more we are willing to pay for timber-related products in order to preserve Old Growth Forests. In closing, I might add that at the current harvest levels it would take about 300 years to cut the remaining Old Growth Forests in the Pacific Northwest, by which time we would have new Old Growth Forests.

STERLING F. CORCORAN, JR.
Sheridan, WY

Dear *Analog:*

I was relieved that you remembered to mention that maybe it's the shrimpers and loggers who should be allowed to go extinct, but wish you'd made the point a little more thoroughly.

It is not the effort to save the species that human destruction is threatening that we should be questioning. The line between what we should exert "heroic measures" to save and what we cannot be held responsible for—the dinosaurs, for example—is by definition the same line as that which our own "handiwork" has destroyed. The Navajo language and culture was not threatened through any lack of adaptability of its own, but because it was bludgeoned by carelessness and firepower. (As for "superior firepower," remember that guns won't feed you when the crops and farmers are gone.)

Diversity is the key to survival. Anyone with an even elementary knowledge of genetics understands that. The same is true of languages—English has been so successful *because* of its willingness to adopt new or "foreign" words and phrases. Loggers and shrimpers must recognize that their current practices are both non-sustainable and obsolete. And speakers of a single language, En-

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glish or otherwise, are going to find themselves in the same position as a field of identical genetic strains when a disease comes along to which they have no resistance.

DIAN L. HARDISON

Cocoa, FL

Dear Mr. Schmidt,

Actually the buggy-whip business (*Analog*, Jan. '92, p. 10) is doing pretty well. Connecticut alone has three manufacturers.

This but indicates the close attention with which I read your excellent periodical.

MARGARET GARDINER

Wiscasset, ME

Dear Stan,

Your editorial, "Evolution and Ethics," in the January issue covered a lot of ground. Beginning with the matter of language, I'm reminded of a story a friend told about his experience in applying for a driver's license after an absence of some years. He didn't mind that he had to take the exam instead of just getting a renewal, but when the clerk asked what language he wanted to take it in, "... Spanish, Chinese, Japanese?" —his response was, "What's wrong with English?"

Almost a century ago, Teddy Roosevelt asserted that "hyphenated" Americans contributed to divisiveness, just as you point out that using a variety of languages makes us "... a hodgepodge of competing ancestries," and didn't imagine that the practice would not only not end in his lifetime, but would actually increase. The Hispanic-American doesn't seem to know if he wants to be that or a Mexican-American, but most Native Americans are certain that they don't want to be called "Indians." Our most recent addition is the African-American, and we're supposed to use that term exclusively. Not only did "Colored" go out in the 1950s, but now "Black" isn't correct, although "White" will do for most of us "Anglos" or whatever we are. Does that make *your* Germanic blood boil to be lumped in the same group as me? Not only do they group us together, neither of us *is* an "Anglo," because my ancestry is Scots, and yours is either German or Swiss, I imagine. Do they *care?* Where's the watchdog to protect us? What about our damned *parades*, and the holidays to honor great Scoto-Americans?

No, we shouldn't allow driver's license exams in Japanese *or* Spanish, because drivers mightn't be able to read traffic signs or understand directions. *And* because it is divisive. And we should stop calling Blacks whatever is correct this year. African-American is *out* for me, as is Native American. I was born here, and the fact that some Navajo's ancestors immigrated to North America a few thousand years before mine doesn't make him more "native" than me.

As for spotted owls, they can't be wiped out just to allow my fellow Washingtonians to earn a living. Not because we need the owls, but because we need the old-growth forests. It's not as easy as you implied for a logger to retrain to computer specialist, though. A buggy-whip fac-

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tory worker could learn to install handles on a Model-T Ford, but a logger might not have the education and skills to be anything but a logger. He's more like a coal miner than a buggy-whip maker. The logger and the miner have skills that don't necessarily translate into any other kind of work, and as long as people want things made of wood, there will be a genuine need for *some* loggers. But we can't allow the big companies to keep on cutting down *all* the old-growth forest. Never mind the owls. Satellite-imaged maps already reveal that Washington is only about half the "Evergreen State" most thought it was. If we keep cutting down the trees, it's all going to be like vast areas of Washington are now, pretty much a desert.

January was an overall excellent issue, by the way, and I was happy to see Sprague de Camp's still cranking out good stories.

JIM HARPER

Bremerton, WA

Dear Editor:

The story, "Pliocene Romance," by L. Sprague de Camp in the January 1993 issue of *Analog* had a nasty anti-gun flavor.

I hope that *Analog* (and Mr. de Camp) is not joining the list of misguided media Second Amendment bashers.

LLOYD A. HAUGER

California City, CA

You must be very careful not to judge the philosophical position of a publication by one piece that appears in it, or even an author by what some of his characters say. Analog, *in particular, does not have an Official Line on much of anything; we can and do publish a wide variety of viewpoints. To alleviate your present concern, I suggest you read Reginald Bretnor's March 1992 Guest Editorial, which drew a barrage of mail quite opposite to yours. It seems everybody's all for freedom of speech and the press, but they still get upset when somebody publishes something* they *don't like!*

Dear Mr. Schmidt:

I just finished Spider Robinson's story in the January 1993 issue of *Analog* and felt compelled to write to correct one item in his story. I realize that his story is fiction, but the AIDS and its origin issue is important enough that I feel it should be made clear that HIV was not introduced into human beings by the Congo polio vaccine tests, as *Rolling Stone* magazine's story reported. I have in front of me the October 30, 1992 issue of *Science* with an article reporting on the findings of a committee set up by the Wistar Institute of Philadelphia. The earliest cases of HIV-1 reported occur *before* the polio trials.

While still unproven, the smart money is still on SIV making the move from monkeys to humans in isolated hill villages, probably during hunting/butchering operations, and then being brought to the cities after WW II, and the breakup of the European colonial empires. There are unconfirmed reports of isolated groups of Africans who show some immunity to HIV, indicating that they have been exposed to it for some time.

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I enjoy Spider's writing, both his fiction, and as a book reviewer for *Analog*. One of the problems with AIDS is the fear and ignorance about it. There are people who claim that AIDS was developed as a weapon against gays, Africans, (pick your minority group) by some other (pick your power) group. (The conspiracy folks need something new now that the "Who shot JFK" thing is losing its punch!) HIV/AIDS is nature in action and a strong reminder that human beings do *not* control nature, not by a long shot. We need to focus on finding the facts and dealing with the problems, not inventing them.

CHARLES R. IRWIN

380 Broadway
Cambridge, MA 02139

Dear Stan:

This letter is not a critique of any of the stories or of any of your wonderful editorials. As a dyed-in-the-wool SF fan since 1928, having been weaned on the stories in *Amazing Stories* and recalling waiting with bated breath the first issue of *Astounding Stories*, I would like to thank the past as well as the present publishers for giving me all these wonderful delights.

I wonder if you can visualize the thrill that I experience almost every day when I see in the news media, television, or hear on radio the fulfillment of all of the predictions that I have been reading about for all these years. The sight of actually seeing men walking on the Moon, Television, Computers, which incidentally is what I am writing this letter upon, the miracles of medical science, of which I am one of the beneficiaries and etc.

MARVIN WINTHROP

Oakland, CA

Dear Mr. Schmidt:

Do editors award medals to columnists for *action above and beyond the call of duty?* If so, let me nominate your reviewer, Tom Easton. When my program, *The Hypertext Hamlet,* wouldn't run on his 286 computer, Easton didn't toss it into the discard box. Instead, he broke the program apart and "fixed" it so that it would work with less memory than the original version. Because of the delay between the time that Easton writes a column and the time that it sees print, his readers are always getting "out-of-date" information. With books printed on paper this doesn't mean much, of course, but with electronic books things can change radically in only a few months. The errors Easton pointed out in his column have been fixed, and a new and more powerful version of the hypertext "engine," DART, has been used to drive the program. For readers whose computers have limited memory, we also now have "The Easton Edition" of *Hamlet.* Thanks, Tom!

JOHN GALUSZKA
Publisher
Serendipity Systems
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UPCOMING EVENTS Anthony Lewis

19-22 August
24th Annual San Diego Comic-Con at San Diego Convention Center, Calif. Guests: Roger Zelazny, Michael Whelan, Robert Williams, Murphy Anderson, Jerry Scott & Rick Kirkman, Charles Vess. Registration: $40 until 10 July ($20 for 7-16 and 60+), $50 ($25) at the door. Info: Comic-Con, Box 128458, San Diego CA 92112. (619) 685-8118.

2-6 September
CONFRANCISCO (51st World Science Fiction Convention) at Parc 55, ANA Hotels, Moskone Centre, San Francisco, Calif. Guest of Honor: Larry Niven; Artist Guest of Honor: Alicia Austin; Fan Guests of Honor: Tom Digby and jan howard finder; MC: Guy Gavriel Kay. Registration at the door—Attending $145 (children 7-12 $30; kids-in-tow 0-8 free). Supporting—$25. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: 712 Bancroft Rd, #1993, Walnut Creek CA 94598. (510) 945-1993. CompuServe 72377,3623.

10-12 September
MINNI-CON (Twin Cities SF conference) at Sunwood Inn, St. Paul, Minn. Guests: Dennis Etchison, Melanie Tem, Steven Rasnic Tem. Registration: $35 in advance; $40 at the door. Info: Minni-con, John Brower, 3136 Park Avenue South, Minneapolis MN 55407-1525.

1-3 October
CONTEXT VI (Central Ohio SF conference) at Hilton Inn North, Columbus, Ohio. Guest of Honor: Frederik Pohl. Info: Context VI, Box 2954, Columbus OH 43216. (614) 263-6089.

1-3 October
FANTASYCON XVIII at the Midland Hotel, Birmingham, England, U.K. Guests of Honour: Peter James and Les Edwards. Info: Fantasycon VXIII, 15 Stanley Road, Morden, Surrey MS4 5DE, U.K.

You can send me e-mail about your convention—A.LEWIS20 on the GEnie™ network. When calling conventions for information—do not call collect. ■

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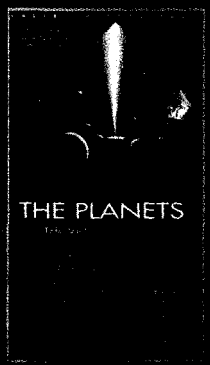

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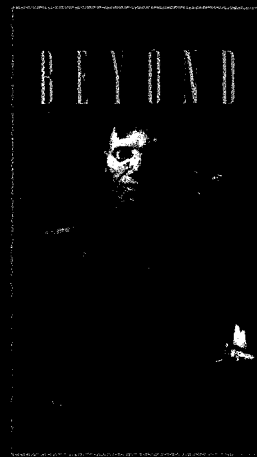

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